Instruments

THE MAGAZINE of MEASUREMENT and CONTROL

Vol. 23 OCTOBER 1950 No. 10

INCLUDING THE *Journal of the Instrument Society of America*

AND THE *Journal of the Southern California Meter Association*

Control Panel of "Weather Factory" for Plant Research at California Institute of Technology *(Story on page 1018)*

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3. FASTER RECOVERY ON LOAD CHANGES

What It Is—A force-balance controller with a new circuit for pneumatic control systems. The new control circuit combines *two* proportional bands, one with rate action in a closed loop ahead of automatic reset. The first band is shifted by the rate action, and the second band is shifted by the automatic reset. This provides control never before believed possible.

What It Does—The new circuit in the TRANSET TRI-ACT Controller permits 4 times faster reset rate and 4 times faster rate action (PRE-ACT) than conventional instruments! The composite effect of the three responses allows start-up and pneumatic setting with NO OVERPEAKING! The faster response settings allow the use of rate and reset responses, *with stability*, on processes where these effects were needed but could not be used.

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- Wider range of response adjustments
- Light weight
- Built-in air strainers

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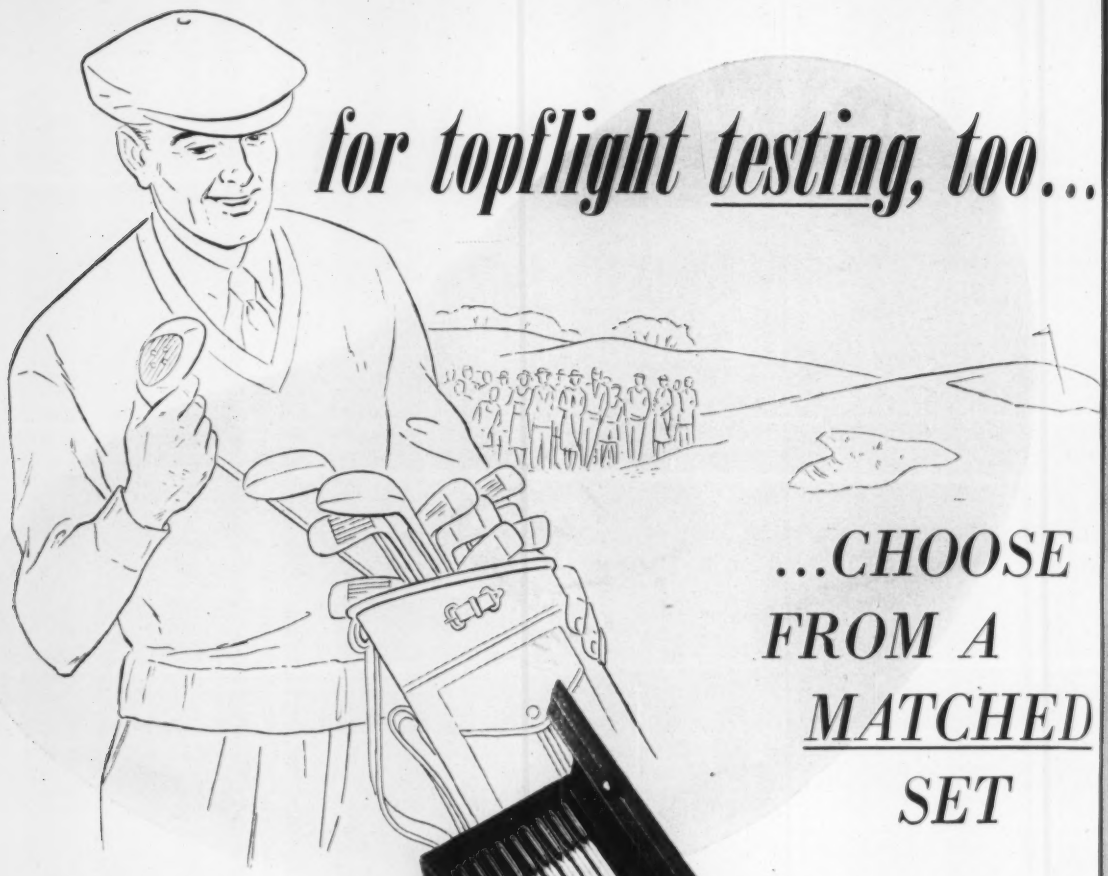

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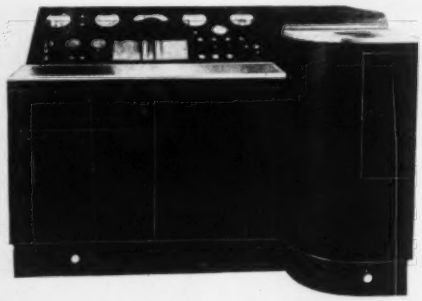

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Instruments

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EDITORIAL

By M. F. BEHAR

An Atmosphere of Poise and Power

IT was only the fifth annual ISA Conference and Exhibit, but those experienced participants and visitors who compared it with the fiftieth—or seventieth—annual meetings of old-established societies could not detect a trace of immaturity or amateurishness. Everything seemed to run like clockwork. And in saying this, we imply the highest compliments to the Buffalo Section and to the National committees and officials who had prepared it and who ran it—for numerous accidents and contretemps did happen (including the sudden death of an Auditorium employee, and a sporting event that took over the Auditorium's main entrance) but so competently were these emergencies handled that few persons other than the committee members noticed that anything was amiss at any time.

There can no longer be the least doubt that Instrument Men are a nationally-recognized occupational group, AND THAT THEY KNOW IT!

We say "occupational group" and not "profession" or "trade" because some Instrument Men are degree-laden scientists and others are technicians; some own their own companies or head departments in great companies and some are newly-hired apprentices; some teach in great universities and some teach themselves alone at home.

Other comments—arranged more-or-less at random:

Attendance

Buffalo being the scene of the Conference and Exhibit, no one expected the attendance to top the figures for Chicago in '47 (7500) or Philadelphia in '48 (13,000) or St. Louis in '49 (5600). Everything considered—including cancellations: kept at work by National Defense work or ordered on active service with the Armed Forces—the total registration of 5300 was gratifying to the arrangement committees of the ISA, AIP, ASME, AIEE and IRE who planned the technical sessions . . . and gratifying to the 140 manufacturers who exhibited. See pages 1000 to 1004 for all photographs received by *Instruments*.

* * *

Wise Employers

As before, some companies not only permitted but ENCOURAGED their Instrument Men to attend the meeting. As usual, Shell Oil led in "total mileage": two men from Holland; one each from England, Curacao, Venezuela and Australia—not counting U. S. mileages.

* * *

Instrument Maintenance Clinic

No classes in hotel private dining rooms this year. Instead, the excellent facilities of the building of the New York State Institute of Applied Arts and Sciences on Elmwood Avenue. Another change: all instructors from industrial plants and labs; none from instrument companies. Attendance broke all records, with 140 "mechanics" completing the three-day course Friday to Sunday preceding the Conference. ("Mechanics" in quotes because, as usual, some older graduate engineers, chemists and physicists took the course.) Major subjects were:

(1) Response of Thermal Bulbs; (2) Fabrication and Calibration of Thermocouples; (3) Strain Gages and Position Indicators; (4) Wet and Dry Meters; (5) Primary Flow Devices; (6) Typical Bridge Circuits—Potentiometers; (7) Shop Practices and Equipment.

* * *

Wanted: Instrument Men.

Proof of the acuteness of the shortage of Instrument Men was obvious in two places:

(1) At the ISA's Employment Committee's desk, which was constantly besieged by representatives of plants and laboratories on the lookout for Instrument Men.

Local employment chairman John Duthie was able to supply only a small fraction of the demand from the committee's "new jobs wanted" cards that he had brought to Buffalo and from the nineteen men who came to look over the opportunities for advancing themselves. In the end, SEVENTY-FOUR attractive jobs remained unfilled—and are still unfilled as we go to press. See the Employment Service columns of the *ISA Journal* in this issue.

(2) At the Naval Ordnance Lab's Employment Information Service desk.

* * *

Women

As was remarked on this page after the Philadelphia Conference and Exhibit two years ago, the expression "Instrument Men" means men and women. This time, the professional women in instrument work were outnumbered by the wives and daughters who accompanied hubbies and dads in order to see Niagara Falls by day and by night, as announced under "Ladies' Program." We learn that these tours, and the others arranged by the women of the ISA Buffalo Section, were thoroughly enjoyable. One wife who has accompanied her husband to many scientific and engineering conventions declared that on no previous occasion was there such rapid melting of the ice that forms when many strange women meet.

* * *

First Showings

It would take a business genius to answer two questions put to old-timers by several exhibitors: "Did we do right in making this show the occasion for unveiling our new model which went into production several months ago?" and "Should we have postponed all publicity on our new model until this show as our competitors did?"

An old-timer who isn't a business genius or any other kind of genius can only answer that he prefers to see optical and mechanical measuring instruments "in the flesh" first, then read the literature; but that he has to study the diagrams of modern multi-tube electronic instruments in advance in order to be able to understand these instruments when he sees them; and that when it comes to new automatic-control systems he can only answer that it depends on their complexity and on the absolute newness of certain special-function components. On the other hand, the latest crops of graduates of postwar courses in Applied Electronics seem to possess the ability of understanding any new electronic instrument after one glance at its chassis: by noting the type numbers and letters etched or printed on its components and deducing all the characteristics of the entire system! But then again, some of these young one-specialty geniuses, when they visit the booths of industrial instrument companies, display a woeful ignorance of mechanical, hydraulic and pneumatic instrument principles. (Evidently, their professors forgot to tell them that the first thing they must do when they start earning their living in the field of measurement and control is to subscribe to *Instruments!*)

So the answer is: "Whatever your company did was right for your own set of circumstances."

* * *

Aisle 700—"All-Navy"

Every year up to now, it has been difficult for anyone who admires every item on display in every booth, and who likes every person on duty, to report on the outstanding exhibit—or exhibits, plural, since there usually were several tied for this distinction.

No difficulty at the Buffalo Auditorium! The U. S. Navy's numerous and diversified exhibits dominated the show like an aircraft-carrier next to a motorboat flotilla. Wisely had those in charge decided against highlighting any single instrument or any single one of the following Navy research-and-development activities which exhibited:

Bureau of Ships, Bureau of Ordnance, Bureau of Aeronautics, Applied Physics Laboratory of Johns Hopkins University, Naval Ordnance Laboratory, Naval Research Laboratory, Aircraft Aeronautical Instrument Laboratory.

The resulting joint display filled an aisle—about one-seventh of the entire exhibit area—yes, almost a second Instrument Exposition in itself! We hope no subscriber will think we show favoritism in giving it the entire first page of the Buffalo Show photographic section in this issue.

Aisle 700 was located along one edge of the exhibit deck (pardon us: floor), so that it was not a "through aisle" like the others but enjoyed semi-privacy. As the visitor entered, he found himself in one long room. He saw no partitioned booths to starboard and port, but found tables and boards lining both bulkheads (walls) and other displays standing along the center-line.

The following is an unofficial, personal, informal account, for the information of our subscribers.

Naval Ordnance Laboratory. This was the fifth consecutive year the NOL unwrapped new instruments and sent courteous young scientists to explain them. Declared one of them: "We not only enjoy coming to these ISA shows but derive benefits personally and for the NOL by examining the new products of the instrument companies. And please tell your sub-

scribers that few NOL instruments are of exclusive NOL design: part of our work is to help inventors and to see that they get financial recognition."

Pictures 4 and 6 show two new NOL instruments. The Time Base Reducer—a time-saving device which most users of multi-channel oscillographs will want—is so simple that the immediate reaction of many visitors was "Why didn't I think of it long ago?"

The Ultra-high-impedance Electrometer-tube Voltmeter is a record-breaker and history-maker in that at 1.5 volts it takes only 0.0005 ergs to drive the pointer full-scale.

To be sure, various types of electrostatic voltmeters have been available for half a century, but whoever heard of any ESVM capable of measuring less than 30 volts? Or capable of determining the polarity of the output voltage from small polarized piezoelectric generators? The NOL's UHI ETVM represents a unique application of the Victoreen subminiature "Type 5800." This tube, when operated as an electrometer tube, i.e., with the "space charge grid" (grid No. 1) operated at a positive potential and the signal applied to grid No. 2, has an input resistance of 10^{15} ohms, and an input capacitance of 2 micromicrofarads. The function of the "space charge grid" is to repel the positive ions which are emitted from the cathode, thus eliminating for all practical purposes any signal grid current. Multiranging (up to 50 volts) is accomplished by varying circuit parameters and using inverse feedback while keeping the tube output linear and of the same value for each range; the output being fed into a conventional two-tube bridge circuit which serves as a current amplifier for actuating a conventional deflection-type instrument.

Bureau of Ordnance. Two displays designated as "shipboard computers" (picture No. 1) and "aviation computers" (picture No. 3) had as a common denominator the remarkable advancement of this new field. Another common denominator is that BuOrd aids the further development of mathematical-function components (and of entire analog computers) by instrument companies and by non-government research institutions.

The Arma analog computer, shown for the first time, has seven input channels and operates with 32 simultaneous equations. It represents the latest technique in analogs for shipboard use, with dials automatically showing the answers to problems, yet weighing one-third and occupying half the volume of former analog computers. It was designed with plug-in components and does not require highly-trained technical personnel to service it. In another BuOrd display, developed by Librascope, Inc., visitors could insert various inputs into manually-operated linkage computer components and watch the components solve the problems for them.

Aviation Ordnance Branch, BuOrd. Thousands of visitors passed the small and simple display of new precision components (picture 3) without realizing that here was a modest violet with a rare fragrance: the far-reaching influence of the instrument-component development program initiated in 1946. The official description of this program's objectives is too modest:

(1) To develop needed instrument components which were not then in existence; (2) To increase performance of instrument components that are applicable to light computing mechanisms; (3) To decrease weight and size of components; (4) To improve instrument behavior at low temperature; (5) To increase life expectancy of instrument components under high ambient temperature; (6) To promote standardization of instrument components; (7) To increase availability; (8) To develop improved computing techniques; (9) To improve resistance to fungus; (10) To improve lubricants for instruments; (11) To develop test apparatus and tools.

On the unostentatious display board were fastened row upon row of new components representing the first results of this development program: synchros, servomotors, "single-package" synchros and servomotors, synchro gyros, tachometers, and other such components. Immediately noticeable was their "family resemblance"—which is not accidental but stems from the uniformity of specifications—specs aimed primarily at standardization of CHARACTERISTICS rather than of mere appearance. Also on the display board—but hardly noticed by most visitors—were humble-looking little resistor rings for stepless voltage dividers—commonly called "potentiometers." One of these, a reddish-brown 1½-inch ring, which looked like a two-cent washer or gasket, represents the fruit of years of Navy-endowed development by a previously-unfamed inventor of conductive plastics.

Publicly shown for the first time, it is not yet listed as a standard item because the long and painstaking work of specifying the complete series of materials is far from over. When it is officially announced as available, the great majority of electrical and electronic instrument manufacturers will find uses for it. Imagine an almost limitless range of resistance values! Imagine a range of temperature coefficients from practically zero to ten percent negative per degree Celsius! Imagine brush-wear resistance so high that new endurance tests must be devised! Imagine age-stability like that of platinum! If you are interested, do not write to the Navy or your editor but wait patiently for the article which an official promised to write for *Instruments* as soon as circumstances permit.

Applied Physics Laboratory (operated at Silver Spring, Md., by Johns Hopkins University as a Navy adjunct). The mobile telemetering equipment (picture No. 2) was the Navy's largest single display. It is no exaggeration to report that this new system can record on the ground or on a ship, with unprecedented accuracy, the measurements made by as many pickups as can be crowded into a rocket, a jet, a pilotless airplane or any other exploratory missile. Twenty-four *types* of measurements (pressures, temperatures, angles, fuel flows, etc.) can be made by the airborne subassemblies.

Naval Research Laboratory. Two new instruments displayed by the NRL for the first time at Buffalo were:

(1) A ground detector which is unique in that it gives directly the resistance values on *energized* as well as on de-energized circuits. (Conventional methods of measuring insulation resistance either involve multiple measurements and calculations, or are not applicable to energized systems.)

(2) A selective gas analyzer, also unique, which makes it possible for the first time to measure ternary mixtures. For example, if products of combustion contain N, H and CO_2 with traces of O, it is possible to indicate either CO_2 or H without having to absorb either of the constituents. The "secret" is a new thermal conductivity bridge insensitive to either H or CO_2 in the ternary mixture.

Bureau of Aeronautics. Younger visitors kept crowding around the tables (picture No. 9) on which were displayed a hundred different types of aircraft instruments, each one sealed in transparent plastic to show its parts. This was BuAer's showing of all declassified aircraft instruments. Another focus of attraction was the instrument panel of a Grumman F7F-3N night fighter (picture No. 5) with its radar screen on which the enemy aircraft is seen at night or through fog.

Noteworthy results of BuAer's program of miniaturization and ruggedization (picture No. 8) consisted of "before-and-after" displays which included:

(1) Old cathode-ray oscillograph weighing 60 pounds, with handles for two men to carry it, and new 14-lb. model; (2) Signal generator, 75 lbs. to 35 lbs.; (3) Audio oscillator, 37 lbs. to 25 lbs.; (4) Pulse generator, 37 lbs. to 13.5 lbs.; (5) Detector amplifier, 55 lbs. to 21 lbs. (6) Switchboard for 50 switches reduced from 1800 to 50 square inches front panel—which took away our breath and made us forget to ask about its weight reduction!

Miniaturization and ruggedization involve new techniques in insulation, lighter cross-sections with reinforcement by struts, new mounting materials, new shock-mountings, new tube grids so sturdy that one official said "you can play ball with these tubes"—all of which means saving ship horsepower and making more room for more ammo—for it must not be forgotten that "a ship is a floating gunmount to carry ordnance where needed." This program has resulted in all-around improvements not only in military instruments but in many types of industrial instruments which our subscribers will soon be able to buy on the open market. In fact, some commercial instruments shown at Buffalo showed the influence of developments by the Navy—AND by the Army AND by the Air Force!

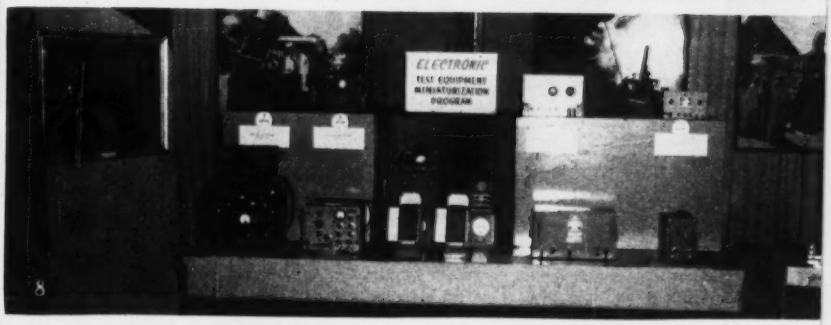
* * *

National Bureau of Standards

Had it not been for the overshadowing Navy exhibit, this report, as in previous years, would have devoted much space to the Proficient and Productive Priests of Precision—the friends and counselors of all Instrument Men—the guardians of standards—the originators of so many of our methods and means. Fortunately, the outstanding new instrument demonstrated at the NBS booth was the subject of an official description which we had received previously and are printing in this issue. So turn to page 1016 and read every word—and imagine the thrill enjoyed by visitors who saw on the CRO screen the entire family of curves of whatever tube was being tested!

Also displayed by the NBS was Doc Rabinow's amazingly simple gadget for reversing an electric motor from full-speed clockwise to full-speed counterclockwise in 0.0035 second (see June issue, page 551); a new high-sensitivity micromanometer with remote-transmitting feature; and various previously-publicized instruments.

Navy exhibits. See editorial



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INSTRUMENT-COMPANY EXHIBITS AT BUFFALO SEPTEMBER 18-22

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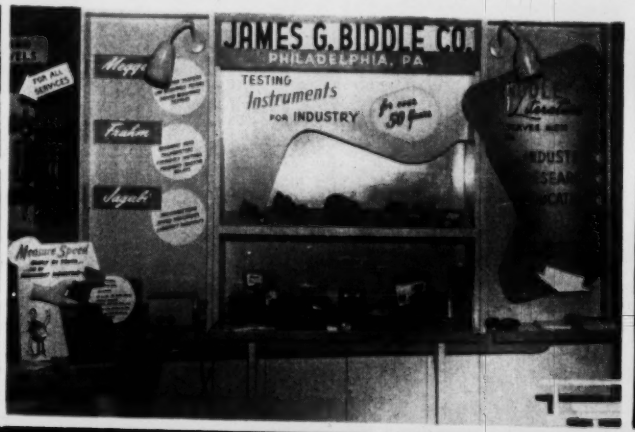

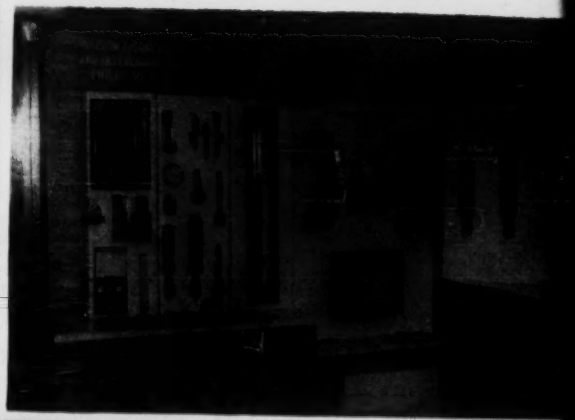

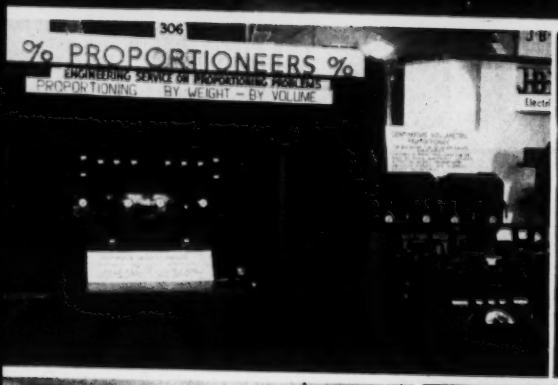

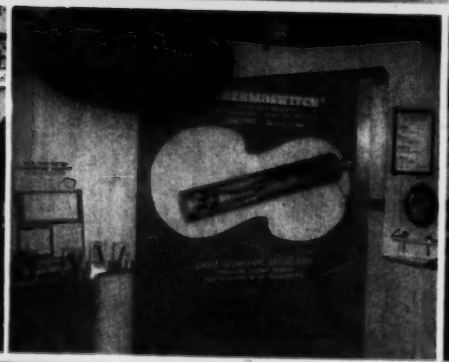

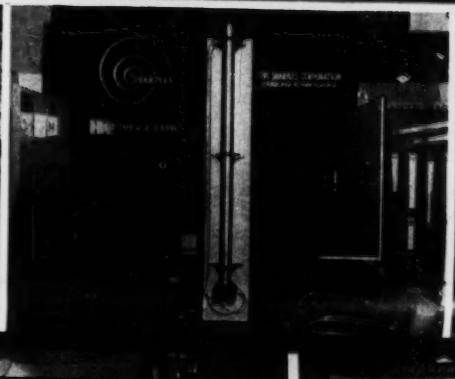

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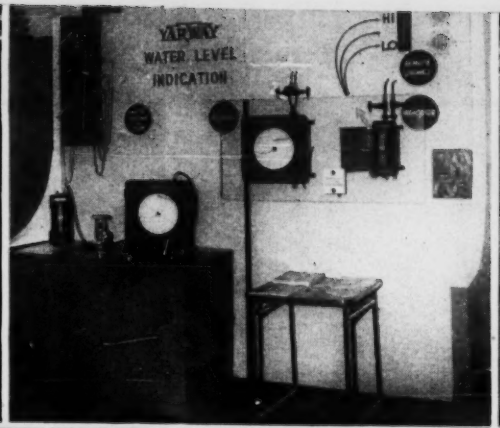

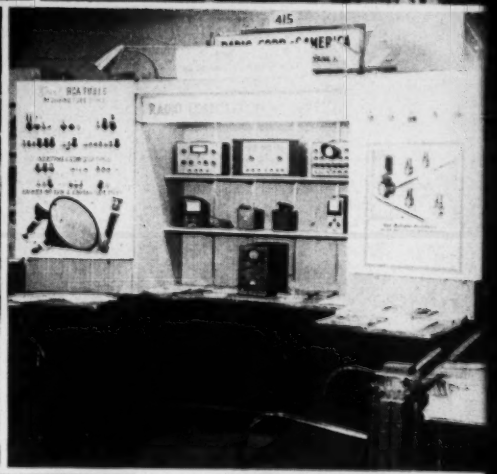

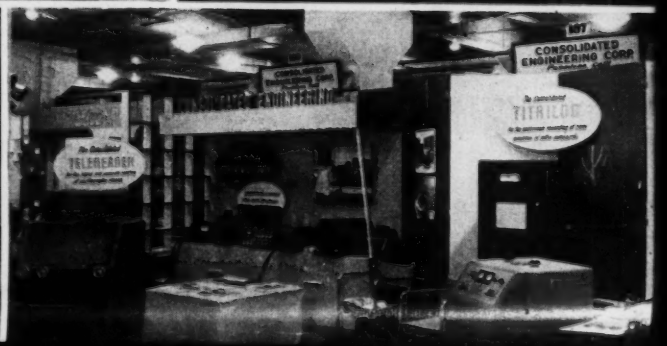

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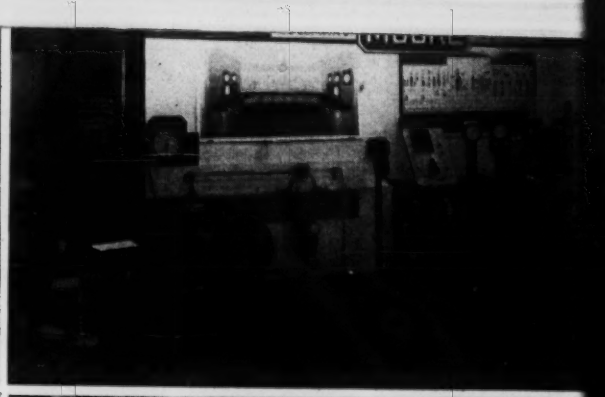
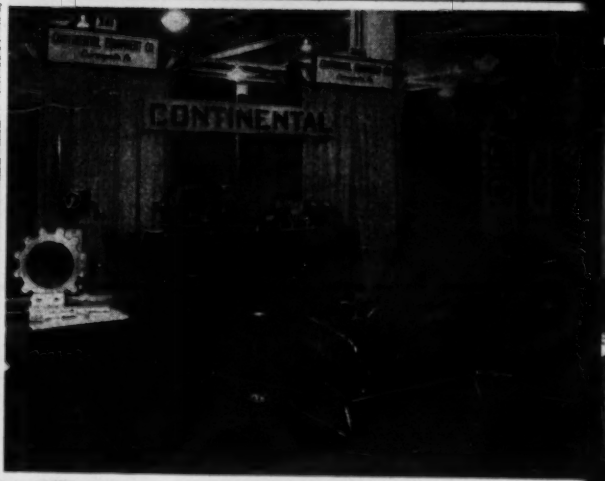
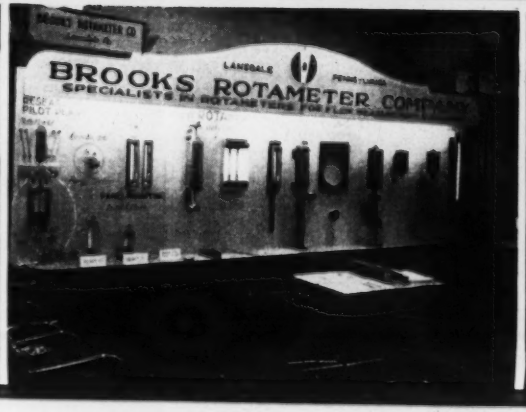
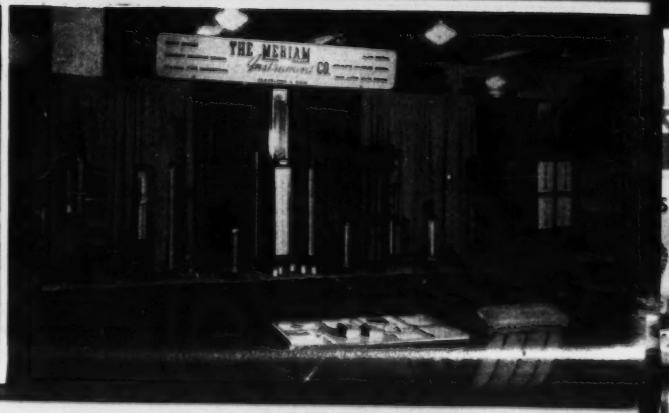








Simple Chatter-proof Relay Control

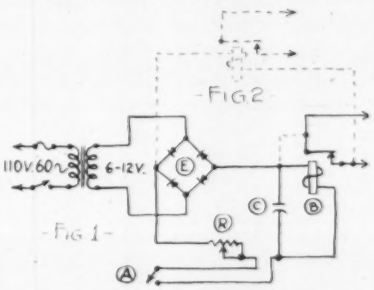
By GEORGE F. SIDDONS, Electronics Dep't, Indiana University, Bloomington, Indiana

SENSITIVE constant-temperature water baths and similar apparatas using sensitive thermoregulators for controlling immersion heaters, cooling coils, stirrers, etc. necessitate the use of a simple electronic relay with variable time delay to eliminate chattering of the relay points.

Most electronic relays described in the literature are unnecessarily elaborate and not suited to simple applications.

Fig. 1 illustrates a simple control device which has a variable time delay, is comparatively fool-proof, has a low maintenance factor, and is economical to construct.

The control apparatus (which could be a sensitive thermoregulator) opens and closes the circuit at A, actuating the relay B. Whenever this circuit is closed, the direct voltage from the selenium bridge rectifier E is impressed across the relay coil which has the capacitor C in parallel. The voltage across this capacitor C increases at a rate dependent on the value of the resistance R and the value of the relay



coil B. When this voltage reaches a predetermined value the relay contacts are closed, placing the controlled apparatus into operation.

As can readily be seen by the dotted portion, identified as Fig. 2, a secondary relay can be added to permit apparatus requiring heavy current drain to be controlled by relays which do not necessarily lend themselves to the design of the apparatus described.

Normally, when the control apparatus A is a sensitive thermoregulator or the liquid level of a still, current greater than a fraction of a milliampere is undesirable. This necessitates a fairly high resistance coil in relay B.

Undoubtedly, there are many applications for a device of this type where relay chattering is annoying to the ear and destructive to relay contact points, and where simplicity and dependability are prerequisite factors. Those that the writer has constructed have been used both with water baths and water stills, and have given excellent service.

Transparent Reference Grid for Cathode-ray Tube

By BILLY M. HORTON, Naval Research Laboratory, Washington, D. C.

IN some recent work it was necessary to make photographic records of the trace of a cathode-ray oscilloscope, from which measurements of zero position and signal amplitude could be made. It was desired that a grid appear on each exposure but that it not obscure the trace. This end was accomplished by the use of a grid consisting of fine lines scratched in the front of a transparent plastic disk. The disk was illuminated internally from a point on the edge, and this internally-reflected light was picked up by the grid lines. In order to provide more uniform illumination, the edges of the disk were polished and covered with aluminum foil to cause the light to reflect back and forth across the disk.

Fig. 1 is a typical photograph using this type of grid. In this work the cathode-ray trace was blanked out except for about 30 microseconds every sixtieth of a second, thus providing observation equally spaced in time. The spots directly behind the grid lines are clearly visible. Exposure details are given with the figure, but the grid lines may be made as bright or faint as desired by varying the intensity of the light source. The rectangular surface at the bottom of the figure has been brightened by scratching. Identifying symbols on tracing paper were placed over this bright area using transparent tape.

The bright region in the upper right-hand part of the figure is caused by light which passes out the back of the disk and is reflected from the cathode-ray tube. This could be eliminated by a design insuring that the light enter the disk essentially parallel to the plane of the disk. More uniform illumination could be achieved by introducing light at several places around the disk or by using a larger disk.

If accurate measurements are desired, the grid should conform to the non-linearity and lack of orthogonality of the x and y deflection in the particular cathode-ray tube with which it is used. Both of these can easily be determined by applying a known d-c. voltage to one pair of plates while a sweep voltage is being applied to the other. The grid was drawn to correct for the angle of deflection but not for non-linearity.

Fig. 1. Reference grid for cathode-ray tube. Grid illuminated through a plastic rod with three -watt incandescent lamps. Exposure time ½ sec. on 35-mm Super XX at f/1.5.

A New Compensated-float Method *of* Liquid-level Gaging *for* Aircraft

By R. G. BALLARD, Aeronautical Engineer, General Electric Co., West Lynn, Mass.

BEFORE describing an improved method of liquid-level gaging for aircraft, a brief review of the art may present a better background for understanding the value to be gained from the new system; in addition, an indication of its proper place in the fuel quantity measurement field may be attained.

Perhaps the first gas gage, and often used at the present time as a checking device, was the measuring stick; this was possibly the most certain measuring method, since it was simple and direct, but its disadvantages are obvious.

Next in simplicity is the "sight tube," consisting of a transparent tube extending below the tank with an index connected directly to a float. This gage, although subject to breakage, performed quite satisfactorily for light airplanes, where the gas tanks were located in the wing where the sight tube was readily visible.

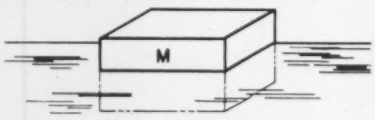


Fig. 1. Mass floating in liquid.

To meet the requirements of more accurate indication, and to provide indications during periods of low visibility, the electrical remote-indicating float gage[1] has been used for many years. As the size of aircraft increased and the range was extended it became necessary to obtain more accurate indications; the capacitance-type[2] gage was developed to meet these requirements. The advantage of this system lay in its lack of moving parts in the tank, its ready adaptability to minimize attitude errors (which are important in multi-engine aircraft where some engines are temporarily inoperative), and the ease of totalization of contents in several tanks. By far the greatest advantage, however, was its ability to measure the mass rather than the volume of liquid.

The ideal measurement system for liquid in aircraft fuel tanks should:

1. Measure total mass of fuel (since available energy is more nearly proportional to mass rather than to volume).

2. Provide accurate indication during all normal attitudes which may be maintained by the aircraft for any appreciable period of time.

3. Meet the requirements of 1 and 2 above, with minimum weight and maintenance.

The float-type gage can be designed to provide mass rather than volume measurement; this is accomplished by a change in the float construction which can be applied to the present tank units and makes use of existing electrical transmission systems.

The principle of operation of the compensated float may be visualized by reference to Fig. 1. A floating mass (M) displaces a quantity of liquid equivalent to the weight of the mass. Thus, for liquids with low specific gravity, the float submerges further into the liquid, and rises for higher specific gravity liquids. This principle has been used for many years in the well-known battery hygrometer, which is calibrated to read specific gravity directly.

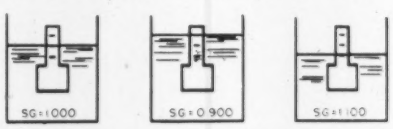


Fig. 2. Effect of change in specific gravity with no change in mass.

A more detailed explanation is illustrated by Fig. 2. The total weight of liquid in 2(a), (b), and (c) is the same, but the specific gravity is different. By proper physical design of the float it will remain at a fixed height above the base of the tank. For the weight of liquid shown in Fig. 2 the gage, to which the float arm is connected in practice, will now provide the correct indication regardless of specific gravity changes. As long as the float remains in an upright position, its change in position with respect to the top surface of the liquid will be the same whether the tank were full or nearly empty.

Further study of the problem indicates that no compensation is required when there is no liquid in the tank, and that the compensation should vary from zero to a maximum value as the tank is filled.

Present float gages provide correct compensation at one point only. For example: Assume that a uniform float submerges to a depth of 0.75 inches in a liquid of 1.00 specific gravity. A change in specific gravity to 1.10 will cause the float to be submerged to a depth of $(1.0/1.1) \times 0.75 = 0.68$ inches. A compensation effect of $0.75 - 0.68 = 0.07$ in. is thus provided; this is the amount of compensation required for a mass of liquid equivalent to 0.77 in. depth at 1.00 specific gravity.

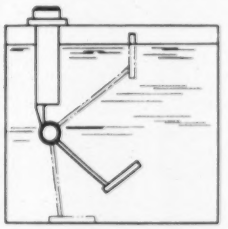


Fig. 3. Application of compensated float.

In order to obtain the desired result, the float is fastened rigidly to the transmitter float arm so that the float essentially rests on its side when the tank is empty; with a float arm movement of approximately 90 degrees from empty to full, the float becomes upright to provide maximum compensation at full tank. This arrangement is illustrated in Fig. 3.

In addition to differences in specific gravity between one lot of fuel

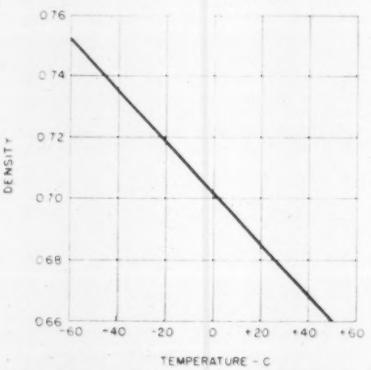


Fig. 4. Density-temperature characteristics for typical aircraft fuel. (Above)

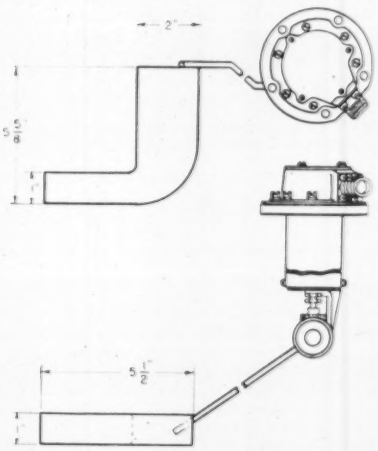


Fig. 5. Compensated float gage with typical float dimensions. (Right)

Presented at Joint IAS-ASME Instrument Specialists' Meeting, Los Angeles, Calif., Oct. 13, 1949.

1. "Totalizing Contents of Aircraft Fuel Tanks," by J. R. Macintyre, *A.I.E.E. Transactions*, Volume 63, June, 1944, Pages 663-665.

2. "A Capacitance-Type Fuel-Measurement System for Aircraft," by D. B. Pearson, *A.I.E.E. Transactions*, Volume 66, September 1947, Pages 1363-1368.

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and another, an additional variation in specific gravity occurs as the temperature of the fuel varies. As the temperature decreases the specific gravity increases, and vice versa, resulting in a change in the volume of the fluid without a change in total mass. Since the compensated float position is determined by the specific gravity of the liquid, the resulting indication is not affected by these temperature changes. The variation of density with temperature, for a typical aircraft fuel, is plotted in Fig. 4.

From the theoretical standpoint, exact compensation can be obtained for a tank of uniform horizontal cross-section area. The "float" would have negligible thickness and the pivot point would be located at the level of the bottom of the tank.

In the practical case, however, it is necessary to take into consideration other factors, namely:

1. Provide sufficient buoyancy to overcome friction effects in transmitter. This requires that appreciable thickness be built into the float. The minimum thickness which can be used is determined by the cross-section area and physical shape of the tank, as determined by the size of tank opening allowable for insertion and mounting of the transmitter. The compensated float of Fig. 5 was designed to meet a specific set of these conditions. Fig. 6 shows the actual sample.

2. Float should move through the proper part of the tank to provide minimum errors for normal variations in attitude of the airplane. For a tank of uniform circular horizontal cross-section, no attitude error would exist if the float moved on the axis of the tank (for all liquid levels where the surface of the liquid is elliptical). Since the conventional float moves through an arc whose radius is much less than infinite in length, a compromise must be accepted.

3. In order to maintain accurate calibration of the compensated float gage it is essential that the float be designed so that it will be impervious to absorption of any liquid; this is even more important than with the standard float-type gage.

4. The length of that part of the float extending through the liquid surface must be at least long enough to compensate for the maximum anticipated change in specific gravity; for example, if a variation of ±5 percent is expected, the float length must be at least 10 percent of the total depth of liquid. This requirement indicates that the float must be designed for each depth of tank.

In summation the compensated-float gage, for a practical installation, must take into account a judicious combination of factors which include:

(a) Theoretical considerations.

(b) Practical mechanical design based upon limiting conditions existing in the airplane.

(c) Vibration and environmental conditions of temperature, pressure and humidity.

In order to evaluate a practical compensated-float gage a sample (Fig. 6) was constructed; this was compared with a conventional float-gage. Two liquids with widely different specific gravities, water and kerosene, were used to obtain the data which are plotted in Fig. 7.

Curve A represents the change in indication for the conventional float gage as like weights of kerosene are substituted for water. Curve B is similar data for the compensated float. These results indicate that this compensated float provides mass indication accurate within approximately one

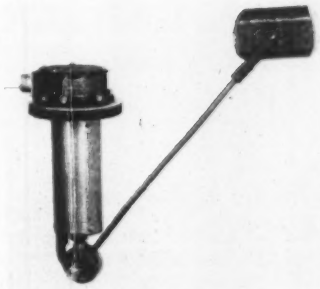

Fig. 6. Standard float-type gage.

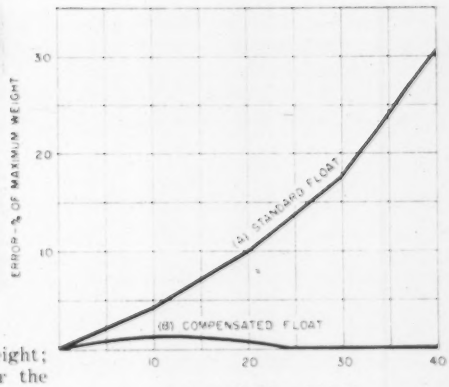

Fig. 7. Error curves for standard versus compensated float.

percent of total "full-tank" weight; this compares with an error, for the conventional float gage, of 30 percent which is approximately equivalent to the percentage difference in specific gravity of the two liquids.

Empty and Full Adustment

Float-type gages are usually provided with both "empty" and "full" adjustments; these adjustments are set during installation of the gage in the aircraft. The zero adjustment is fixed before liquid is put in the tank, a given volume of liquid corresponding to "full tank" is pumped in, and the "full" adjustment set for correct full indication. For proper adjustment of the compensated float, the zero setting will be made at empty tank as before; then a given *mass* of fuel must be added to permit the full adjustment to be made properly.

Totalization

Accurate totalization of the liquid in two or more tanks may be a major problem by reason of variations in tank size and shape. With the float-type gage, it is essential that each transmitter be designed to provide the same current change per unit mass of liquid; this is similar to the design of the capacitor gage where it is necessary to obtain the same capacity change per unit mass of liquid for all tank units.

Mechanically, the above requirements may dictate a non-uniform voltage-divider winding in the float-type gage (which is relatively difficult to produce), and non-uniform capacity between the capacitor plates in the capacitor gage.

Conclusion. A method of compensation has been described for liquid level gages of the float type. This may be adapted to existing installation, making use of present a-c. and d-c. electrical systems. The advantages of simplicity, ease of maintenance, light weight and lower cost outweigh, for many aircraft requirements, the possible disadvantages of moving parts in the tank unit.

TENTATIVE STANDARD

MECHANICAL AND ELECTRIC CHART DRIVE SPEEDS

RECORDER-CONTROLLER SECTION OF
SCIENTIFIC APPARATUS MAKERS ASSOCIATION

FOREWORD

Recorder-Controller Section of Scientific Apparatus Makers Association Tentative Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining without delay the proper product for his particular need. Existence of a Recorder-Controller Section Tentative Standard does not in any respect preclude any member or non-member from manufacturing or selling products not conforming with the standard.

1. Scope and Purpose

1.1 This standard applies to Chart Drives for recording or controlling industrial instruments. N.B. It does not apply to cam operated controlers.

1.2 The purpose of this standard is to establish certain rotational speeds as standards in an effort to cover the applications in the industrial field adequately while saving customers, suppliers, and manufacturers expense resulting from the excessive number of rotational speeds called for and made available. It is hoped that in standardizing, a secondary result may be not only a less expensive, but an improved product.

2. Terminology and General Definitions

2.1 The following definitions give the meaning of the terms as used in this standard.

2.2 Mechanical Chart Drive. A mechanical chart drive is a clock-like mechanism rotating a spindle to which charts may be fastened. The driving power comes from a hand wound main spring.

2.3 Electric Chart Drive. An electric chart drive is a clock-like mechanism rotating a spindle to which charts may be fastened. The driving power comes from an electric motor.

2.4 Cam Operated Controller. A cam operated controller is an instrument having in part a mechanism, practically identical with the chart drives covered by this standard, which is used to drive a cam. The rotational requirements are different from those listed for chart drives, and are not covered by this standard.

3. Mechanical Chart Drive Speeds

3.1 Standard:

(a) Single Speed:	(b) Two-Speed:
8 hour	96 minute 24 hour
12 hour	24 hour 7 day
24 hour	
48 hour	
7 day	

4. Electric Chart Drive Speeds

4.1 Standard:

4 minute	12 hour
24 minute	24 hour
96 minute	48 hour
8 hour	7 day

UNESCO and the Instrument Industry

By RICHARD RIMBACH, Publisher of *Instruments*

A NEWS RELEASE dated August 14, 1950 and just received from the United Nations Educational, Scientific and Cultural Organization in Paris, is printed below. Every reader of *Instruments*, every American manufacturer of scientific instruments, every U.S. citizen, every member of the Senate and Congress, and the President of the U.S.A., would do well to read this very interesting statement.

The "convention" which Unesco is circulating "to all its Member States, and to Members of the United Nations" will be an entering wedge on the part of foreign manufacturers of scientific instruments and laboratory apparatus to "abolish" our Tariff Laws by circumventing the treaty-making powers of the U. S. Senate.

Why does our Secretary of State waste the time, money and manpower to send his representatives to Torquay, England, to discuss a reduction in tariff duties? (Mentioned on the editorial page of the September issue of *Instruments*.) Any agreements arrived at Torquay will theoretically require ratification by the Senate. On the other hand, according to the statements in the accompanying release ("It [the Unesco 'convention'] will be open for signature at Lake Success, New York shortly and will come into force following ratification by ten countries"), it will not be necessary for the U.S.A. to sign the "convention." Unesco has 59 Member States.

Tariff reductions, which already have put many employees in the Instrument Industry out of work, will now bring about the Truman administration's ruinous free trade policy without benefit of the Senate. Surrendering the American instrument market to foreign producers of scientific and laboratory instruments will not only reduce still further the employment in the U.S.A. Instrument Industry but will reduce our ability to produce the weapons for defense and will make it impossible to provide the instruments required by our Armed Forces.

A similar attempt was made in 1929. I quote below from the editorial in the May 1929 issue of *Instruments*:

The following is an extract from a statement of Major R. W. Pinger, representing the War Department in open hearing of Ways and Means Committee on February 23rd, 1929:

"The Assistant Secretary of War has designated me to appear and show the relation existing between the scientific instrument industry and national defense.

"I have a typical scientific instrument . . . only one of some 200 items which the Ordnance Department is supposed to furnish the Army of the United States in time of War. The other departments, Medical, Chemical Warfare, Engineers, Air Corps and Signal Corps all have somewhat similar but smaller problems.

"Anything in the tariff which tends to injure the scientific instrument industry which would make these things in time of war would be prejudicial to the national defense.

"I would like to read a statement by Mr. Benedict Crowell, Assistant Secretary of War during the late war:

> "'The optical industry in the country before the war was in the hands of few firms. Several of these were under German influence and one firm was directly affiliated with the Carl Zeiss works of Jena, Germany . . . optical glass was procured entirely from abroad and chiefly from Germany.
>
> "'There has been developed in this country a manufacturing capacity for precision optical and instrument work, which, if desired, will render us independent of foreign markets.
>
> "'At the present time American manufacturers are in a position to make instruments of precision equal to the best European product, and the industry will continue, provided there is an adequate market for its product. Such a market will exist if universities and commercial laboratories of the country will obtain scientific apparatus from American manufacturers rather than import it from abroad as was the custom.'

"Three years later the 1922 Tariff eliminated duty-free importation, thereby giving protection which not merely the industry but our scheme of national defense needed."

At that time the attack on our Tariff Laws was made by foreign instrument manufacturers; now it is being made by an organization of a supergovernment. In 1929 I wrote an answer to these attacks and this answer is reproduced on the following pages.

Every American reader of *Instruments* should write or wire the Senators from his State and the Congressman from his district to avert this attempt to withdraw our tariff protection and throw away America's future.

UNESCO/MC/RO 3
Paris, 14 August 1950

UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

WORLD AGREEMENT WILL ABOLISH DUTIES ON SCIENCE EQUIPMENT, BOOKS AND FILMS

Scientific instruments, apparatus and collections intended for education or research will enjoy duty-free entry under a new international agreement which Unesco is sponsoring as a means of reducing barriers to world trade in educational, scientific and cultural materials. The text of the convention was approved by Unesco's 59 Member States attending the recent General Conference of the Organization in Florence.

The "Agreement on the Importation of Educational, Scientific and Cultural Materials" will also permit the free import of books, newspapers, periodicals, maps and charts. To aid their circulation further, contracting governments will grant licenses and foreign exchange for publications consigned to public libraries. A special article in the convention provides for the duty-free entry of all books and other educational material for the blind.

Duties will also be lifted from educational, scientific or cultural films, filmstrips, newsreels and sound recordings. Paintings, drawings and sculpture will likewise be freed from tariff restrictions.

Scientific instruments and apparatus will enjoy exemption provided, firstly, that they are intended solely for educational or research purposes and are destined for recognized educational or scientific institutions; secondly, that materials of equal scientific value are not already being manufactured in the importing country. Other materials which will be admitted duty-free, if consigned to approved institutions, include patterns, models and wall charts; and architectural, industrial or engineering plans or designs.

Unesco is circulating the convention to all its Member States, and to Members of the United Nations. It will be open for signature at Lake Success, New York shortly and will come into force following ratification by ten countries.

The United Kingdom Government has announced that it will submit the text to Parliament for ratification. Belgium, France, Luxembourg, the Netherlands and Switzerland are among other countries which are expected to take quick action for legislative approval.

Following its adoption at Florence, the Director-General of Unesco, Dr. Jaime Torres Bodet, said the new world pact represented a substantial contribution, in the technical field, to mutual understanding and peace. He urged swift action to bring it into force.

This is the second international agreement to be sponsored by Unesco. The first, which is designed to abolish duties, quotas and licenses hindering the movement of films, recordings and other audio-visual aids to education, has now been signed by 18 countries and ratified by 3 (Norway, Yugoslavia and Pakistan).

Both conventions are expected to be of considerable aid to importers and exporters in countries taking part in Unesco's International Coupon Scheme, since they will lift tariff and other restrictions on materials which the scheme covers—books, periodicals, scientific materials and educational or scientific films . . .

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The Proposed Tariff and Instruments

Richard Rimbach

IN the March 29th and April 5th issues of SCIENCE there appeared advertisements of foreign scientific instrument manufacturers, which attack the proposed tariff on imported scientific instruments. These (reproduced on the following pages) strike the editor as being an unfounded reflection on the American scientific instrument industry.

As some of the statements made in these advertisements are not in accord with the facts and tend to give the instrument user a false impression of the purpose and results of the proposed tariff, the following facts are submitted.

These advertisements, which are very similar in general tone, state that the proposed tariff "may soon double the price of all scientific

PROPOSED TARIFF and ITS RESULTS!

"A tax on Research and Science"

"It may soon double the price of all scientific apparatus"

THIS IS EVIDENT:

apparatus." Similar predictions were made in 1919 when a pamphlet signed "Friends of Science" was distributed throughout America by foreign manufacturers.

The "Friends of Science" Circular said that the 1922 Tariff would promptly result in manufacturers advancing their prices, and domestic instruments will reach a level of price to cause further serious concern to the teaching institution, with the result of retarding scientific progress.

The facts set forth in the following editorial in Industrial and Engineering Chemistry, April 1929, show that just the reverse has happened.

The American Economist, January 7, 1921, exposed the "Friends of Science" Circular in an article entitled "Propoganda for German Instruments," in which it said:

> "If the instigators of this circular were as much interested in the advancement of science and education as they would have us believe they are, then why make an anonymous plea?
>
> "The fact is, more likely, the authors of the above propaganda are importers of microscopes and kindred instruments, who are thriving at the expense of American labor. Unless the domestic production is given the benefit of protection, the Germans will have full control of the market, the domestic industry having been wiped out of existence. Prices will then rise anad educational, scientific and philisophical institutions will pay more."

The statement is made that an increase in duty had been asked for on Microscopes and accessories, etc. This is contrary to the facts. The exact words of the American instrument industries' recommendation are:

THIS handy gauge is widely used for measuring low pressures, drafts and differentials—such as furnace drafts, pressure drop across filters, and velocity pressures; also pressure drop across displacement meters and pressure measurement on bell provers.

It is a direct reading instrument with an inclined tube giving increased scale length to permit accurate readings of fractional inches of water pressure.

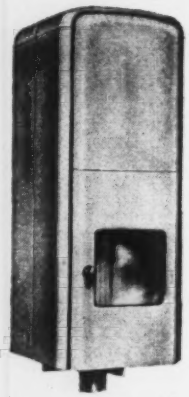
Housing is of dull black crackle with bracket for wall mounting, having two adjusting screws for leveling. Each gauge is individually calibrated, insuring extremely accurate operation.

Available in Single-Tube, Two-Tube and Three-Tube styles. Sturdily built for long, carefree service. Each gauge is furnished with standard accessories ready for operation. Write for Bulletin 4.

THE MERIAM INSTRUMENT COMPANY
10958 Madison Avenue, Cleveland 2, Ohio
Western Division: 1418 Wilson Ave., San Marino 9, Calif.
In Canada: Peacock Bros., Ltd., Montreal

MERIAM Instruments
ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES

HOUSING PROBLEM SOLVED... at low cost!



New Gilbarco instrument housings for petroleum and chemical industries.

- **Available in four sizes.**
- **Die-formed of automobile body steel.**
- **Completely weatherproofed, insulated.**
- **Available with or without 11" square glass windows.**
- **For wall mounting, horizontal pipe mounting or pedestal pipe mounting.**

Easy to read and adjust instruments, replace tapes or recording discs. Can be disassembled *without tools!* In addition to housing process control instruments, Gilbarco cabinets are being used for outdoor manual or motor-operated control valves, small vertical pumps, fire blankets, weather stations, outdoor interplant telephones, bulk terminal gauges, and many other purposes.

Write for full information

Gilbarco

GILBERT AND BARKER MANUFACTURING CO.
West Springfield, Mass.

VECO GAS ANALYZER CELL

Sealed In Glass For:

- **CONSTANT ACCURACY**
- **LONGER LIFE**
- **TROUBLE-FREE SERVICE**

In a VECO cell all sensitive elements are sealed in glass—protected from clogging residues—safe with explosive gases, unaffected by corrosive gases. VECO gives researchers a higher efficiency with its dependable trouble-free service and constant calibration. Write for details.

END THIS!

This enlarged photo shows carbon and oil impurities clogged in old-style unprotected filament after chemical or exhaust gas analysis. Result is changed resistance, inaccurate readings, after short use.

Victory ENGINEERING CORPORATION

744 Broad St. Newark, New Jersey **VECO CELLS**

ELECTRONIC AND THERMAL CONTROL INSTRUMENTS • ACTUATORS • GAS CELLS
COMBUSTION TYPE STARTERS • FINE WIRE PLATING • PURIFIED ZIRCONIUM

That "Sextants, octants, photographic and projection lenses, opera and field glasses, telescopes, **microscopes and other optical instruments,**" be classified under paragraph 228 at 45% duty exactly as they have been classified for the last seven years, and were classified in the 1909 tariff.

This advertisement states further that "Recommendation has further more been made that duty be assessed on a basis of U. S. value instead of the present method." The American scientific instrument industry never made such a recommendation.

Under the caption "THIS IS EVIDENT," the foreign advertisement then lists five things, which will supposedly happen, if the new tariff act becomes effective. These are considered in sequence below.

1: The admitted purpose of the tariff is to permit the manufacturer of a country to overcome unfair competition due to lower labor charges, depreciated currency, Government subsidies, cartels and other artificial advantages.

The names of the three English firms—Adam Hilger, R. J. Beck and W. Watson & Sons are drawn in with the German firms. In England scientific instruments and apparatus are classified in their Tariff as "Key Industry Goods" and carry 50% duty, the highest ad valorem duty in their entire tariff—they make no exceptions.

xxvi SCIENCE—ADVERTISEMENTS

PRESERVED

TARIFF

...to 1922 the duty on scientific instruments was 20% with a provision for duty free ...educational, etc., institutions.

The tariff law of 1922 increased the duty to 45% and abolished duty free importation.

At present a determined effort is being made to increase the duty further, even up to 60%, and to change the valuation system which will increase the duty still more.

Higher Duty Means Higher Prices

for the domestic product as well as for the imported one. The domestic manufacturer, having already in the present rate a more than ample protection, would have such a margin to play with, that competition of foreign made instruments in this country would become almost impossible. Imported instruments on account of their relatively high prices have maintained themselves on the market with difficulty. Generally speaking they have sales possibilities only if they are of obviously better quality than competing domestic instruments, or if there are no similar domestic instruments. A still higher duty may make importation practically prohibitive and establish a monopoly for the small group of domestic manufacturers.

Among others the following organizations have protested against the proposed changes in the tariff:

The Purchasing Agents of Universities and Colleges have filed a brief both with the Ways and Means Committee and the Senate Finance Committee asking for duty free importation for educational institutions. Referring to the present Tariff Act they say: "It is not exaggerating in the least to state that education is being taxed, a condition which is universally accepted as being a deterrent to education advancement."

The American Association of Museums filed a brief also asking for the continuation of duty free entry, quoting from a letter of the Philadelphia Academy of Natural Sciences, "The payment of duty on scientific instruments is to us a very serious matter. Inasmuch as in many cases instruments of similar character are not produced in America, the question of competition does not necessarily enter into the situation. In consequence we feel called upon to state our proposition very definitely as opposed to the levying of duty on scientific instruments engaged in direct research."

The American Medical Association has similarly "filed a protest with the Committee on Ways and Means against the proposed increase of the duty on surgical instruments. Physicians interested in this matter as individuals or as organizations, and the responsible officers of hospitals, if they desire to record the payment as a deferred item for surgical instruments as may reasonably be expected from the proposed increase in the duty on such instruments, will do well to file protest with the Committee on Ways and Means of the House of Representatives and with their respective Representatives."

Similar protests have been filed by the American Hospital Organization.

Scientists and organizations who are opposed to a further increase in duty may send their protests to the Committee on Ways and Means on whose hands the matter is at present, and later to the Senate Finance Committee, also to the Representatives and Senators of their districts.

The respective paragraphs of the present tariff law of 1922 are:

Schedule 3—Paragraph 358, dealing with optical instruments.
" 3— " 360, dealing with surgical, etc., instruments.
" 3— " 368, dealing with "philosophical, scientific and laboratory instruments and apparatus, etc."

CARL ZEISS, Inc., 485 Fifth Avenue, New York

When the War came the English exacted a promise of protection for the scientific instrument industry which they would have to develop—that promise has been redeemed. The Americans did not ask for promises, they went ahead and developed the industry.

The following is extracted from an editorial in the INSTRUMENT WORLD (an English Instrument publication):

SAFEGUARDING AND SCIENTIFIC INSTRUMENTS

The procedure to which the label "Safeguarding" is applied has been the subject of many warm discussions by industrialists, economists and politicians. An admirable review of the whole matter has recently been published in the TIMES TRADE AND ENGINEERING SUPPLEMENT.

The Safeguarding of Industries Act, 1921, had two objects. One was the safeguarding of a definite list of so-called "key industries"; the second was to make provision against the effects of the depreciation of currencies of certain foreign countries.

Among those products safeguarded were, of course: optical glass, optical elements and instruments, scientific and lamp-blown glassware, laboratory porcelain, scientific instruments, gauges, wireless valves and vacuum tubes.

Discussing the vital question—What is a Key Industry?—the writer of the TIMES articles says, of instruments in particular:

"The vital importance of optical instruments and the optical glass and elements required in their manufacture, for the military, naval, and air forces, and for every kind of scientific and medical research and the supervision of industrial processes, needs no demonstration. The fact that before the War nine-tenths of the optical glass used in this country (England) was imported from the Continent, and that the British optical instrument industry, though very efficient, was so limited in range and output that there was very great difficulty in supplying the requirements of the Forces, are sufficient evidence of the need for some aid to both branches of the industry."

Again: "The schedule heading 'scientific instruments' covers a wide range of non-optical instruments which are absolutely essen-

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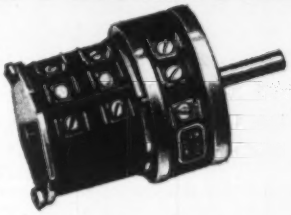
SPECIAL APPLICATIONS

GANGED LINEAR AND NON-LINEAR POTENTIOMETERS



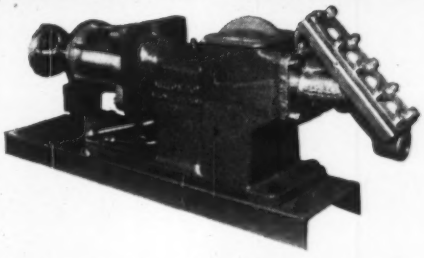
This three-gang precision potentiometer assembly is just one more example of Fairchild's answer to customers' special-application problems.

The assembly combines on a common shaft, two 736 non-linear potentiometers, specially wound to an empirical function, with a highly accurate (±.15%) 747 linear unit. Ganging in this manner saves considerable space and virtually eliminates error accumulation such as would occur if each unit were operated on its own shaft.

Fairchild's Potentiometer Sample Laboratory engineers can help you in analyzing your special applications. Write complete details on your requirements to Dept. 140-11B1, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

Fairchild
CAMERA AND INSTRUMENT CORPORATION

MILTON Roy PUMPS



New! "aiROYmetric"

CONTROLLED VOLUME CHEMICAL PUMPS

These are positive displacement, precision metering units, with the exclusive Milton Roy double-ball check liquid ends, powered by simple air cylinders. Plunger stroke length (capacity) is adjustable while operating by means of screw and hand-wheel. Capacities from 0.4 to 405 GPH. Pressures to 20,000 psi. Plunger diameters from $\frac{5}{16}$" to $3\frac{1}{2}$". For controlled volume pumping . . . practically all chemicals, slurries, solids in suspension etc. Sanitary liquid ends are available. Ideal units for automatic feed systems. *Write for Bulletin 450.*

MILTON Roy COMPANY
1309 E. MERMAID AVE., CHESTNUT HILL, PHILA. 18, PA.

SEEING IS BELIEVING WITH Rochester STAINLESS STEEL DIAL THERMOMETERS

Extremely sensitive, accurate and durably made of high quality stainless steel, you can depend upon Rochester Dial Thermometers to indicate temperature changes quickly in all types of service. There is no squinting at hard-to-see mercury columns. Big, bold dials permit you to take readings at a glance. You see quickly . . . and can believe what you see!

The new precision bi-metallic element is extremely sensitive, quickly reflecting temperature changes. It is free from indicator vibration and extremes in temperature do not cause distortion. Rugged construction guarantees long life. All exposed parts are stainless steel.

Rochester Dial Thermometers are available in many types, stem lengths and scale ranges. For specifications and prices on these or any other combinations, mail form.

No. 1725=3" dial No. 1750=2" dial No. 1825=6" dial
Stem lengths $2\frac{1}{4}$", $3\frac{1}{2}$", 6", 9", 12", 15", 18", 24"
One piece Sockets—to fit all stem lengths

TEMPERATURE RANGES

Fahrenheit	Centigrade	Dual Scale
—50 to 120°F. 50 to 350°F.	—70 to 160°C.	—90 to 130°F.
—70 to 150°F. 0 to 500°F.	—10 to 110°C.	—70 to 56°C.
0 to 200°F. 150 to 750°F.	0 to 150°C.	
0 to 300°F. *200 to 1000°F.	0 to 300°C.	
30 to 240°F.	100 to 400°C.	

*Not recommended for continuous operation above 800°F.

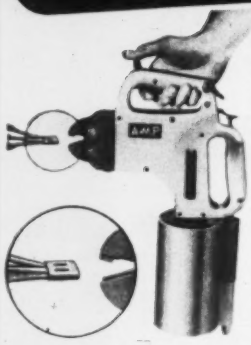
Rochester
GUARANTEED ACCURACY

ROCHESTER MANUFACTURING CO., INC.
85 Rockwood St., Rochester 10, N. Y.

We require ..... dial thermometers with temperature range of ..... to .....°; ..... " dial; ..... " stem.
Please quote.

Name ..... Title .....
Company .....
Address .....
City ..... State .....

"stub" position crimps are possible with AMP'S NEW PNEUMATIC TOOL



INTERCHANGEABLE HEADS FOR CRIMPING SOLDERLESS TERMINALS ON WIRE SIZES FROM #6 TO #1/0.

This sturdy AMP tool features interchangeable crimping heads for either conventional "side position" or novel "end" position crimping, as well as a double set of handles and triggers. A suspension loop enables tool to be supported from above. Air cylinder is constructed of seamless tool steel—safety factor 300%. Toggle action jaws insure complete crimping cycle. Operates from standard shop outlets of 85 p.s.i.

AMP

AIRCRAFT-MARINE PRODUCTS INC.
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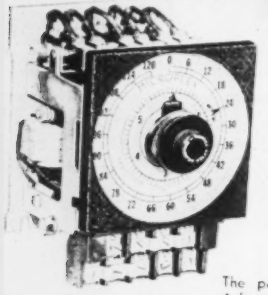
CANADIAN REPRESENTATIVE: R. M. Hutcheson, 10 Nordale Crescent, Hardington, P. O., Toronto 15, Ont., Canada
AMP Trade Mark Reg. U. S. Pat. Off.

U. S. Patents Pending

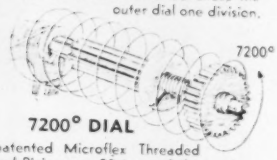
ELgin 5647

Eagle MICROFLEX RESET TIMER



MICRO TIME SETTINGS

The double Microflex Dial permits setting the timer right on the dot—like a Micrometer. One complete turn of the inner dial advances the outer dial one division.



7200° DIAL

The patented Microflex Threaded Axle and Pinion uses 20 turns of the dial. Multiplied 20 times, 7200°, for more accuracy.

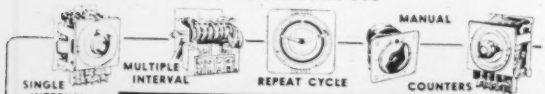
•WIDER RANGE OF ADJUSTMENT

Your machines equipped with Microflex Timers will have added utility. Jobs requiring short or long time period can be accurately controlled by setting the Micro Dial.

•OVER 100 TIMER OPERATING COMBINATIONS

Each one of the three separate Microflex contacts can be set for seven different actions. Selection of the exact combination desired will eliminate additional relays.

Write for BULLETIN 110



AN EAGLE TIMER FOR EVERY TIMING PROBLEM!

EAGLE SIGNAL CORPORATION Moline Illinois

tal for the fighting forces, and are of primary importance also for physical and chemical research work and in many industrial operations.

It was undoubtedly in the minds of those who framed the 1921 Act to select for safeguarding industries of high future potentialities. They realized—perhaps even more clearly than the members of those industries selected for safeguarding—that future prosperity and progress would very largely depend on the virility and both technical and financial advancement of the "key industries." How far the passage of time has materialized the hopes entertained must be left for others to judge.—Instrument World, London, Jan. 1929, page 260.

2. Prices for domestic instruments are not influenced by the tariff. The 1922 tariff increased the duties and since then the American prices have been reduced, as is evidenced by th following editorial in the April issue of INDUSTRIAL & ENGINEERING CHEMISTRY.

> The man who buys a quadruple-effect, centrifugal of high capacity, a diffusion battery, or a list of modern filter presses may be inclined to pass by as unimportant laboratory equipment and supplies. But the successful operation of plant equipment practically always depends upon laboratory control, and new equipment is both designed and installed as the result of problems laboriously worked out with laboratory equipment. It seems fitting, therefore, to call attention to contributions which have been made of late to the progress of chemistry in America by the makers of scientific apparatus.
>
> This is not the place to discuss new pieces of equipment or new sources of supply, but we do wish to point out that the cost of laboratory equipment to the user is lower now than it was before the Tariff Act of 1922 was passed. Comparing the prices of 1920 with those of 1929, it is found that, with a quality and accuracy higher than at the earlier date, the average price of chemical glassware, such as "resistance" glass beakers and flasks, burettes, cylinders, pipettes, separatory and chemical funnels, is 24% lower. Glassware with a low coefficient of expansion is sold in quantities for 9% less, and smaller quantities than formerly enjoy this reduction.
>
> In metal apparatus, where substantial improvements have been made in design and construction, the prices of one manufacturer are 27.7% lower than in 1920, while the average of 1000 different items taken from another list shows a 17.4% decrease, and only 5% of the lot show an increase in price. In all these cases the higher cost was due to expensive improvements.
>
> In another shop, labor-saving devices have enabled better apparatus to be sold at prices which show an average decrease of 23.2% in selling prices. In chemical porcelain ware a flat 40% reduction has been made in the sales prices applying to over 400 different items. In optical instruments many have been completely redesigned and so greatly improved that a comparison between 1920 and 1929 is impossible. If these new non-comparative items are eliminated and the computation is made according to sales as a whole, there is a decrease of 8.4%. For example, a microscope sold in large numbers is now priced at $120, as compared with $132 in 1920. If the new types of instruments are included in the calculations, an increase of but 3% in the sales price of the entire list is shown, notwithstanding a wage increase of 14.5% during the period under discussion. In electrical heating appliances, a decrease of 18.1% is registered, though here again marked improvements have been made in design and construction.
>
> One hundred and seven important chemical reagents show a decline of 21.4% in price, while another list of 600 chemicals shows a reduction of 26%. The latter manufacturer listed 750 chemicals in 1920 and now lists 2490. The comparison as above is not the complete picture, for some of these items can only be sold in small quantities, are of very little interest to chemists as a whole, and because of their limited sale show small change in price. However, this may be just as important an item in the progress of the science as one which can be sold in large quantities and on which the price can therefore be lower. It is estimated that a weighted average of this list of chemical reagents would show a price reduction of more than 50% as compared with current prices in 1920. The price of the entire line of domestic laboratory equipment and supplies has been reduced 18% since 1920 and this has forced a reduction in the prices of items imported from Europe. In many cases today the "Auslander" prices to America are lower than the domestic prices in the exporting country which is the reverse of the policy prior to 1914.
>
> All of these data are interesting as showing the effort of the scientific apparatus maker and the manufacturer of reagent and research chemicals in America to deal fairly with their customers, to make improvements wherever possible, and not to lose sight of their responsibility.—Industrial & Engineering Chemistry, April 1929, Page 298.

3. At the present time there are but few instruments which are not manufactured here. The American manufacturers are able to make instruments equal to the best foreign product.

The following is an extract from a statement of Mr. Benedict Crowell, Assistant Secretary of War during the late war:

> At the present time American manufacturers are in a position to make instruments of precision equal to the best European product, and the industry will continue, provided there is an adequate market for its product.

4. No monopoly will be created, as there are a large number of instrument manufacturers in this country. Over 200 manufacturers, both large and small, are listed in INSTRUMENTS' files.

5. Our American protective tariff is called "a tax on research" whereas the American Scientific instrument industry is recognized by the research workers as essential to their work. Dr. E. R. Weidlein Director of The Mellon Institute of Industrial Research, in a letter to the Ways and Means Committee, says: "We depend constantly upon these home industries to meet our daily necessities. I do not advise the extension of duty-free privileges." Another Research Director

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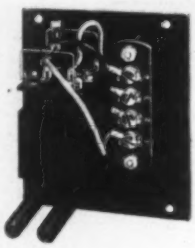
Low cost gas analysis!

ACCURATE . . .
SENSITIVE . . .
COMPACT . . .
RUGGED . . .

with GOW-MAC EVER-TITE THERMAL CONDUCTIVITY UNITS



New gas flow systems and cell geometry feature the improved 1950 GOW-MAC models. The filaments used in the various cells are evaluated and selected to higher standards than ever.

GOW-MAC IMPROVED STANDARD ON PANEL

The best all-purpose T/C cell. Standard fittings permit high flexibility in gas flow train arrangements; diffusion passages suitable for wide variation in gas sample flow rate. Especially good for student work. M/K or M/T filaments.

RECORDER CONTROLLER MODELS

Double mass for greater heat inertia. Super selection for highest heat stability.

Write for the new bulletin OF-950

GOW-MAC INSTRUMENT CO.
22 LAWRENCE ST., NEWARK 5, NEW JERSEY

MARSHALLTOWN DIAL THERMOMETERS

New STAINLESS STEEL BULB AND NUT

THE COMPLETE LINE

Now furnished in stainless steel bulb and nut, Marshalltown dial thermometers are accurate, compact, durable instruments for the indication of liquid or gas temperatures. They are available in a variety of temperature ranges from minus 40° F. to plus 500° F. Actuation is positive, direct with full freedom — no gears or pinions. Available in sizes 2", 2½", 3½" and 4½".

WRITE TODAY FOR FULL DETAILS AND PRICES

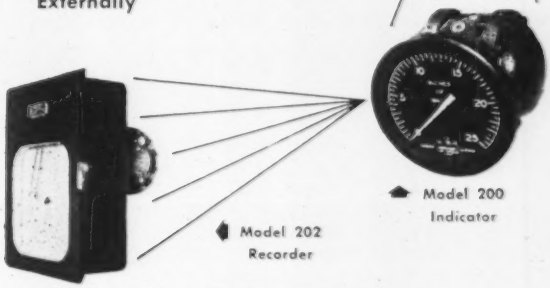
Marshalltown Mfg. Co., Marshalltown, Iowa

IT COSTS YOU NOTHING TO KEEP A

FLOWMETER ACCURATE

That's right—Barton Flowmeters need no maintenance at all. The usual sources of trouble, such as loss or emulsification of mercury . . . pressure-bearing leaks . . . the need to lubricate . . . condensates collecting in the housing . . . over-ranging damage . . . pen flutter—all have been eliminated, thanks to these exclusive features:

- **Rupture-Proof Stainless Steel Bellows**
- **Torque-Tube Drive**
- **Self-Draining Housings**
- **Pulsation Dampener, Adjustable Externally**



Model 200 Indicator

Model 202 Recorder

for measuring:

FLOW • LIQUID LEVEL • DIFFERENTIAL PRESSURE

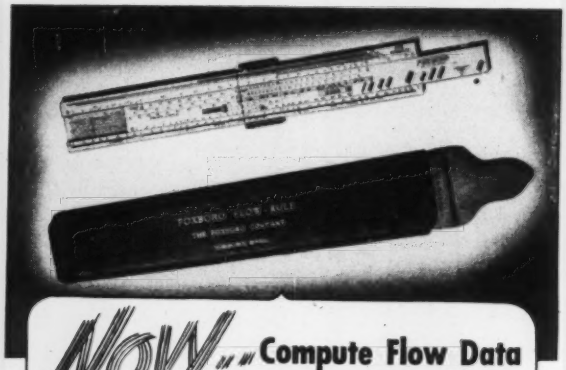
Write for details on the service-free construction of Barton Meters in Bulletin 11C4.

1925-1950

25 YEARS OF PIONEERING BRING YOU THE MODERN BARTON FLOWMETER

BARTON INSTRUMENT CORPORATION

1431 SO. EASTERN AVE., LOS ANGELES 22, CALIF.



NOW... Compute Flow Data by SLIDE-RULE!

● Without curves, tables or calculating machine, you can now make speedy calculations of flow data within the accuracy of usual tests. The new Foxboro 12" Flow Rule, designed specifically for flow calculations, can be used for all fluids—for computing orifice, nozzle or venturi sizes, flow rates, orifice differentials and other information.

This handy aid is finely, accurately constructed from moisture-proof, non-warping plastic. Price complete with leather case, $25. Send your check or formal order to **The Foxboro Co., Book Dept., Foxboro, Mass.**

THE FOXBORO COMPANY
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VIBRATION Fatigue Tests POINT THE WAY TO IMPROVED PRODUCTS

MODEL 100VA
CAPACITY 100 Lbs.
Produces Vibrations Vertically

You can be sure if your products pass a vibration fatigue test—substantiates design and construction materials—frequently exposes excessive material. Many things can be learned from tests. A "must" for electronic, aircraft and automotive parts and assemblies. Hundreds in use. Models to handle parts from 10 lbs. to 100 lbs.—choice of vertical or horizontal table movement. Frequencies of 600 to 3,600 v.p.m. Special machines to order. Catalog F contains treatise.

Made by the makers of All American 16X Microscope for carbide surface inspection

ALL AMERICAN
Tool & Manufacturing Co.
1010 FULLERTON PKWY., CHICAGO 14

J. V. N. Door, says that the duty-free importation of scientific instruments would create a barrier to scientific research in America by depriving its laboratories of a domestic source of supply for the appliances with which to work. Dr. E. C. K. Mees, Director of Research, Eastman Kodak Company, in a letter to the Ways and Means Committee, states: "As the Director of a large research laboratory who is extremely interested in seeing research prosper in this country, I respectfully beg to advise that the duty-free privilege suggested be not extended in the new tariff bill now pending." This same attitude is held by many research men throughout the country.

The advertisement states that the Educational Buyers' Association have definitely opposed an increase in tariff rates and recommend a return to duty-free importation of scientific apparatus. Many "Educational Buyers" appreciate that spending on the American basis is consistent with the privilege of earning and receiving on the American basis. Several Members of that Association have already protested against duty-free importation.

The total annual expenditures of educational institutes for scientific equipment, when compared to building maintenance, salaries, libraries, athletics, etc., represents so small a percentage of the total annual expenditures, that were all expenditures for scientific apparatus curtailed the reduction in total expenditures would be inappreciable.

The John Price Jones Corporation reports gifts to educational institutions of 129 million dollars in 12 months (1928). Surely the American protective tariff policy contributed to the prosperity that made there gifts possible. To put the products of a particular group of American workmen on a duty-free basis means that those workmen must sell their time on the lower foreign basis or obtain other employment. If the idea of asking particular groups of Americans to sell their services on a duty-free basis is to effect a material saving to educational institutions, the instrument makers would be about the last group called upon in the order of expenditures.

Major R. W. Pinger, representing the War Department of the United States in open hearing of the Ways and Means Committee stated:

> In the seven years which have followed (1922) the scientific instrument industry has become more efficient. However nothing has occured which makes it one whit less important to the military, and for that matter, naval, protection of the country. On the contrary, the scientific progress in the martial arts emphasizes more than ever our dependence thereon. It is believed that the **RESTORATION OF THE DUTY-FREE PRIVILEGE TO UNIVERSITIES—WOULD BE OF SERIOUS DETRIMENT TO THE NATIONAL DEFENSE.**

The advertisement also states that the "American Association of Museums had filed a brief opposing duty on instruments for scientific institutions engaged in direct research." They did state an intention to do so, but when they learned the facts they filed a brief saying that they did not advocate free entry for research. A copy of the paragraph added to the brief with reference to Paragraph 1706 of the free list follows:

> In order to correct a misunderstanding that has developed, we call attention to the fact that we do not here or elsewhere advocate free entry of optical or other instruments for purposes of research by institutions engaged in research. We did intend to offer a suggestion to the effect, but we withdrew the point. The suggestion to which reference is made in the foregoing two paragraphs, namely, that of free entry for technology exhibits, is obviously a different matter altogether, and we believe that it is one of no consequence to the instrument industry.
>
> AMERICAN ASSOCIATION OF MUSEUMS

"HEAT INERTIA" IN PROBLEMS OF AUTOMATIC CONTROL OF TEMPERATURE

By VICTOR BROIDA
Consulting Engineer and
Process Control Specialist,
PARIS, FRANCE

Stiff paper, 5¼ x 8¼ inches, 64 pages

$1.00 POSTPAID

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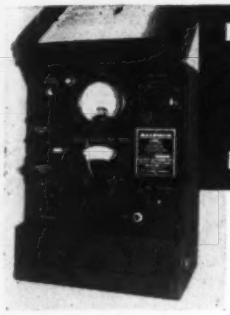

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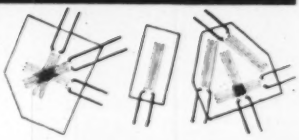

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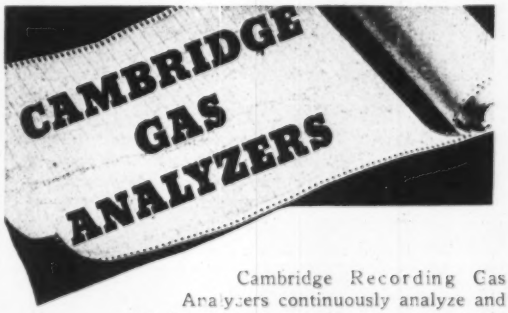

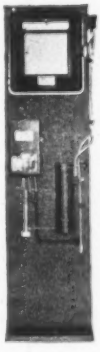

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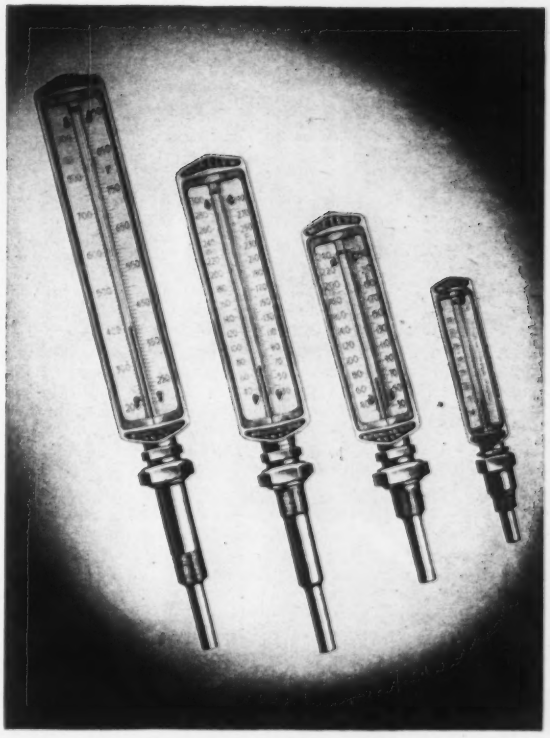

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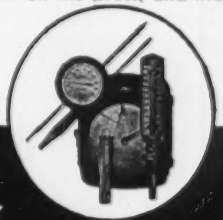

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INSTRUMENTS ON THE MARCH

Curve Generator for Electron Tubes

WASHINGTON, D. C.—An instrument which gives an instantaneous visual display of electron tube charcteristics has been developed by Milton L. Kuder at the National Bureau of Standards. The curve generator plots directly on the screen of a cathode-ray oscilloscope the family of plate current versus plate voltage curves for any receiving tube. A standard rectangle is displayed along with the characteristic curves to provide a direct scale for voltage and current readings. In cases where the tube characteristics are not known or where an unusual combination of supply voltages is to be used, the curve generator can provide the necessary tube data at a great saving in time and labor.

The plate voltage applied to the tube under test is swept continuously from zero to predetermined positive values. The voltage drop appearing across the plate load resistance is then a measure of the plate current. This voltage drop is applied to the vertical deflecting plates of a cathode-ray oscilloscope and the plate voltage itself to the horizontal plates. The combined voltages generate a plate current—plate voltage curve on the oscilloscope screen for the entire sweep interval. The sweep sequence is repeated automatically for several values of grid bias, forming the family of plate characteristic curves. A series of bright dots appearing at the end of each curve in the family gives a useful representation of the load line of the tube for the operating conditions selected.

In addition to producing plate characteristic curves, the new instrument can provide a visual representation of plate current versus grid voltage. In this case the oscilloscope display is particularly convenient since grid voltage increments are directly defined by calibrated vertical bars appearing on the oscilloscope screen; a standard current reference is given by a horizontal bar. All of the possible displays are produced by the curve generator without overloading the tube under test. Over-all accuracy of voltage and current readings from the oscilloscope screen is within plus or minus five percent.

A complete family of curves is retraced sixty times a second; the resulting image is stationary and free from flicker. Characteristic curves may be quickly obtained in permanent form by photographing the screen image with a regular oscillograph camera. Electronic research and development organizations would find this procedure extremely valuable on many occasions.

All of the driving signals are produced in the generator by a single master oscillator. Voltage excursions for the tube under test are obtained from the oscillator in the form of a rising sawtooth wave whose magnitude is controlled without any oscillator loading effect. A cathode follower isolates the power supply for the tube under test from the rest of the generator circuit, so that only the plate current of the tested tube is plotted on the oscilloscope.

When the sawtooth plate sweep signal is most negative, the master oscillator sends a pulse into a pulse former. Pulses from the pulse former then operate a step counter to provide a fixed bias voltage for the grid of the tube under test, successively becoming more positive. Each time the plate voltage is driven negative the grid bias voltage rises to a new level. These stepwise increasing bias voltages are fed through a video divider which reduces their amplitude to the desired level. From the divider they go through a cathode follower to the test grid. A special control acting on a clipper circuit allows manual selection of a definite calibrated voltage for the highest positive grid step.

A special linearizing circuit provides for uniform increments in the step sequence of grid voltages, each oscillator pulse, through an inverse feedback arrangement, transferring a fixed charge into a large capacitor. The feedback can be controlled manually to provide any size grid voltage increment. The number of steps is controlled indirectly by the output of a step counter, arresting the entire process after a predetermined number of steps.

Two circuits have been included in the design of the characteristic curve generator which are not vitally necessary but which add to the convenience and reliability of the instrument. One is a "servo-sweep" circuit whose timing is controlled through the frame synchronizing switch. This circuit is especially useful for viewing the step-function signal at the grid of the tube under test. Another circuit, using four tubes, identifies the curves which have positive values of grid bias by means of a small marking "pip" superimposed on the positive grid lines. The curve generator, essentially as described here, will be available commercially in the near future.

Recording Microwave Refractometer

WASHINGTON, D. C.—An instrument which measures and records small differences in frequency between two resonant cavities has been developed by George Birnbaum at the National Bureau of Standards. In its present form, the new instrument can be adjusted over a wide band of microwave frequencies for measurement of dielectric constants of lossless gases and changes in the dielectric constant of such gases and extremely-low-loss liquids and solids. According to NBS Technical Report, 1425, the extremely high sensitivity of this instrument permits operation with small test samples. The microwave refractometer should be readily adaptable to manufacture as a field model since the microwave components and electronic circuits are straight-forward and compact. It has direct application in several fields of scientific research and industrial production, providing a convenient method for continuous monitoring of impurities in gases or liquids and for rapid testing of small solid samples. It could also be used as an ultramicrometer and to measure the thermal expansion of cavity materials.

The key operating principle of the refractometer is the comparison of two cavity resonators. A test sample (gas, liquid, or solid) is introduced into one of two otherwise identical cavities. The resultant difference in resonance frequency between the two cavities is then a measure of the dielectric constant of the test sample. Tests have shown that the sensitivity of the present instrument under lab-

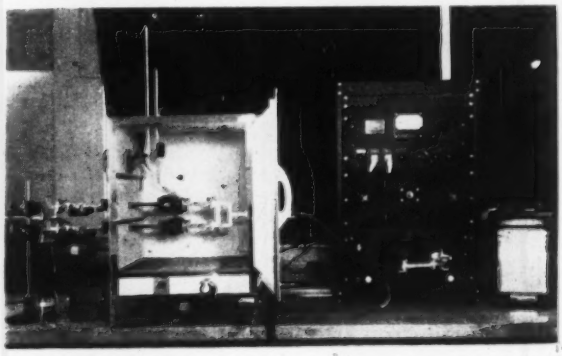


Fig. 1. The recording microwave refractometer as used to measure the refractive index of an artificially controlled atmosphere. A klystron oscillator with its associated sawtooth generator occupies the lower panel of the cabinet at right. The klystron output, frequency-modulated with a sawtooth wave, is fed through a flexible waveguide to a T-junction inside the temperature-controlled cabinet (center). The T-junction divides the signal between two cavity resonators, test and reference, respectively. The cavity outputs are passed through crystal detectors (left) and then back through coaxial lines to identical amplifier and pulse sharpener circuits (top panel at right). The combined output is graphed by the recorder (far right).

ratory conditions is 200 cps. at an operating frequency of 9000 Mc.

A klystron oscillator is used as a microwave signal source and is frequency-modulated with a sawtooth wave. The radio-frequency output from the klystron is fed to a T-junction which sends equal parts of the signal to the two cavity resonators, one functioning as a test cavity, the other as a frequency reference. The cavity outputs are then fed through identical crystal detectors, amplifiers, and pulse sharpeners. The pulse pairs, repeated at a rate determined by the sawtooth frequency, then go to a trigger circuit. The first pulse turns it on and the second turns it off. The output of the trigger circuit is a rectangular wave with constant amplitude but variable width. The average value of this wave as measured in an instrument circuit is then directly proportional to the frequency difference between the two cavities, provided that the "on-time" of the trigger circuit is also directly proportional to the frequency difference. The circuits have been designed to give this linear relation between time and frequency.

In calibrating the microwave refractometer, it is desirable to use rare gases such as argon or helium whose dielectric constants have been measured very precisely at optical frequencies. However, for greater convenience in actual operation the reference cavity has been equipped with a tuning plunger calibrated essentially in terms of the gas pressure in the test cavity.

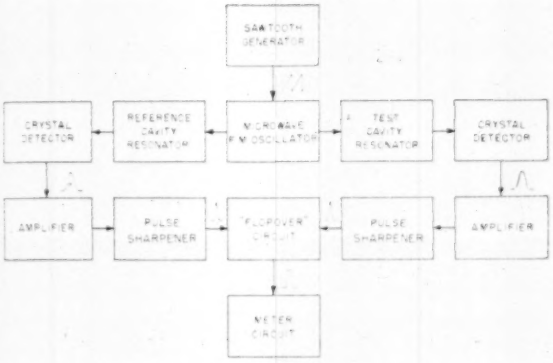


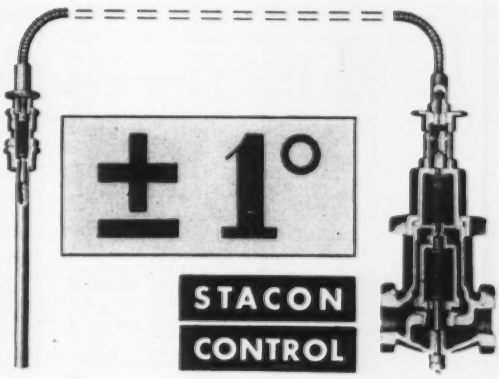
Fig. 2. Block diagram of recording microwave refractometer.

The maximum sensitivity achievable by the refractometer is determined by its short-time stability, which depends essentially on background noise. Long-time stability depends chiefly on variations in temperature difference between the two cavities and the drift in center frequency of the klystron with temperature. When long-time stability is needed, both of these effects can be controlled by proper temperature regulation.

With solids and liquids, high sensitivity to small changes in dielectric constant could be obtained by filling the entire test cavity with the material. But, except in the case of practically lossless substances, this would seriously decrease the Q of the cavity. On the other hand, if only a small fraction of the cavity volume is occupied by a low-loss substance (a small diameter cylinder is convenient for this work) the Q would not be appreciably affected and sufficient sensitivity would be maintained. The position of the sample with respect to the electric field in the cavity will determine the sensitivity of the refractometer to changes in dielectric constant. Small liquid samples can be measured in the same way by placing the liquid in a quartz tube.

The restriction to low-loss materials is necessary because the present equipment is sensitive to changes in the Q of the test cavity. However, a direct extension of present techniques would avoid this limitation completely and permit simultaneous recording of changes in dielectric constant and loss.

In measuring the dielectric constants of gases, it often is convenient to use a flow technique in which a continuous stream of gas is drawn through the test cavity. This method has actually been used in a preliminary experiment to



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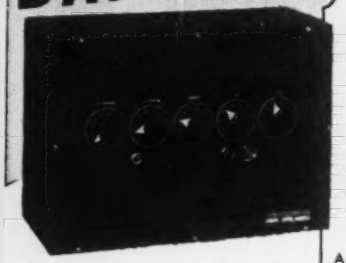

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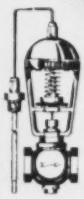

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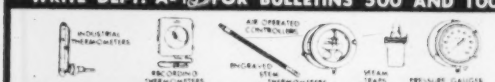

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record variations in the dielectric constant of an artificially controlled atmosphere.

Similar measurements of the atmosphere are needed in radio propagation and meteorology. The recording microwave refractometer is now being studied for possible application to measurement of atmospheric refractive index. Such measurements might help to explain how high radio field intensities are produced at great distances by atmospheric scattering and "duct" processes. Many of the radio observations thus far made at frequencies above 30 Mc. cannot be explained by the ordinary refraction and diffraction calculations. Above 30 Mc., the change in refractive index with altitude and the fluctuations in refractive index in any small region of the atmosphere have a direct effect on radio propagation.

New Device for Calibrating Watthour Meters

PROVIDENCE, R. I.—A new device described as providing a faster and easier means of calibrating watthour meters, particularly in field tests, was reported by H. F. Robison and W. H. Wickham, of the Commonwealth Edison Co., Chicago, Ill., at the North Eastern District Meeting of the American Institute of Electrical Engineers held here in the Sheraton-Biltmore Hotel.

According to the authors, the new device is faster because "an instantaneous and continuous visual indication of meter accuracy is obtained. It is easier because the indication is definite and clear. The tester is subjected to less eye strain than in the close observation of meter disks. In general, closer adjustment to correct registration is obtained than by the methods involving successive trails. The device is portable and no special disks, disk markings or the like are required for its application."

In describing the device the authors said, "The standard watthour meter is permanently equipped with an optical system and photocell. For the test meter, a spare cover of the type on the meter under test is equipped with a bracket on which a similar optical system and photocell can be mounted. This cover temporarily replaces the regular meter cover for test purposes.

"The new watthour meter calibrating device has been used for calibrating station meters for a period of about eight months. In this time it has been found that accurate calibration by this method requires only one-third as much time as the conventional method of counting revolutions. The device detects erratic disk motion such as caused by defective bearings or by foreign material on the disks or magnets much more readily than the conventional method.

"It has been found that the tester can observe the action of the trace on the cathode-ray screen over long periods of time with no appreciable eye strain.

"The sensitivity of the detecting device is such that meters can be calibrated with an accuracy of 0.1 percent."

Caltech's "Weather Factory" Depends on Instrumentation

PASADENA, Calif.—America and the rest of the world may, within the foreseeable future, reap not only more vegetables per acre, but get harvests with increased nutritional value over those on the market today. With an increase in basic knowledge of plants, combined with improvements in agricultural methods and extension of cultivated areas, a 20 percent increase in world food productivity is a distinct possibility.

Such predictions were made by Dr. Frits Went, California Institute of Technology plant physiologist in commenting on the first year of basic research in Caltech's

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Earhart Plant Research Laboratory. The research is conducted in six air-conditioned greenhouses and thirteen air-conditioned laboratories on the Caltech campus.

These greenhouses and laboratories are automatically controlled as to temperature and light conditions by a specially built Minneapolis-Honeywell control panel and a time-clock panel for controlling lights which was constructed by Caltech scientists. Through these two panels, both of which can be controlled from the superintendent's office, it has been possible to control and duplicate weather conditions anywhere in the world at any time.

In picturing the possibility of not only increasing food productivity but also its nutritional value through research in such laboratories as that at Caltech, Dr. Went also warned of the dangers in uncontrolled smog. He cited the case of Los Angeles, where extensive damage to Southern California's truck farming industry is already an established fact (estimates as high as $2,000,000 damage annually have been made) and also the fact that smog did damage to plants in the new laboratory. Plant research in Southern California has shown, he says, that smog may one day make the growing of vegetable crops economically impractical in all areas within smogging distance of any highly industrialized city.

Dr. Went's statements are based on the result of a year of patient plant experimentation under the most exactly controlled conditions of weather, light, temperature and sterility existing anywhere in the world today.

The Earhart Laboratory, which has been called a Phytotron (to plant researchers as a Cyclotron is to physicists), is a half-million-dollar "weather factory."

Purpose of the research there, according to Dr. Went, is to get more basic information about plants. Such information may be used as the basis for not only increasing yield but also to increase the efficiency of plants by determining the conditions under which they will convert more light into chemical energy.

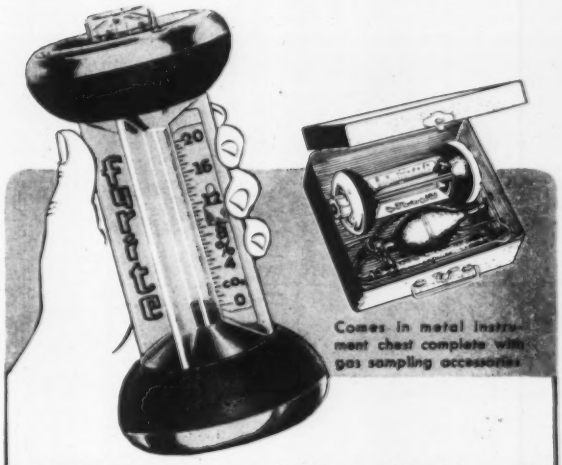
Tomatoes and sugar beets have been the main guinea pigs so far. It was already known, Dr. Went said, that less than two percent of the light energy given these plants in the fields was converted into chemical energy. Research in the laboratory under controlled conditions of temperature, light and weather variations showed that a potential of 10 to 15 percent conversion from light energy to chemical energy in the plants is possible.

It has been particularly noted, he said, that night conditions of both light and temperature had a particularly beneficial effect on the plants. That this was true has been known for quite some time. In Hawaii, night lighting of sugar cane fields increased the yield by a considerable percentage, showing that this discovery has immediate practical effects.

In working with sugar beets under controlled conditions it has been found, Dr. Went said, that under ideal conditions an acre of sugar beets might be doubled or trebled as to quantity and energy potential (conversion of light energy to chemical energy). If, as some believe, our supply of natural crude oil will some day be exhausted, the sugar beet may assume new importance as a source of alcohol as a susbstitute for gasoline, he said.

Tomato research brought out the fact that climatic conditions were far more important than was generally credited in the growing of farm products. Until recently, Dr. Went said, it was thought that growth of flowers and plants was controlled by daylight conditions of light and temperature. This was discovered to be untrue. The night temperature was just as important. Some plants, for example, grew only when the temperature was under 50 degrees Fahrenheit at night. Other plants, when temperature was above 50. It was found that tomato plants grew almost as fast at night under controlled temperatures as they did under daylight conditions.

Because temperature control to fractions of a degree in all the greenhouses and laboratories was so important to the research, Dr. Went and his associates called in engineers and scientific personnel of the Minneapolis-Honeywell Regulator Co. to design the special and complicated temperature control panel. All controls in the Phytotron are of the pneumatic type. Their flexibility, says Dr. Went,



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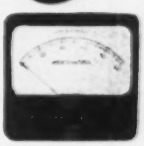

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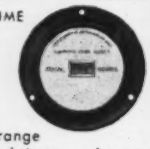

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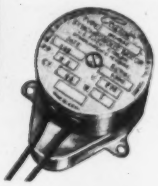

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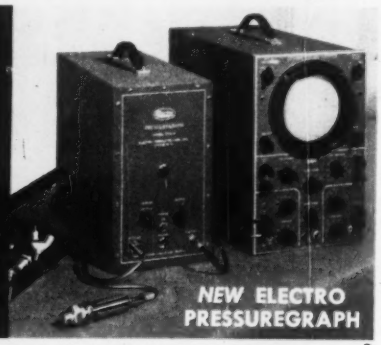

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is remarkable and the control is positive and easily regulated. Each circuit from the greenhouses and laboratories ends in a small petcock in front of the panel and thus all circuits can be inter-connected in any desired manner. This, explained Dr. Went, provides for unlimited flexibility.

Although the smog problem was not a direct part of the research plan, it became an important factor in the plant experimentation because smog came into the laboratory and began having an adverse effect on the growing of tomato plants, sugar beet plants, tobacco plants, and other vegetables.

It was found that some of the gases in smog were toxic to plants. The plants were visibly damaged. Spinach and romaine in the laboratories were damaged enough to make them unsaleable; other plants such as celery, cabbage, endive, chard, lettuce, barley, alfalfa, and beets were also damaged. Electric precipitators failed to remove damaging gases in smog.

Further research, said Dr. Went, showed that activated carbon filters would de-smog the laboratory. Such a filter was installed. Plants grown in this room were healthy. It was also found that plants which were never exposed to smog were healthier than those which had been exposed and then were moved to a smog-free atmosphere.

"Although our experiments with smog are just a by-product of our plant research," Dr. Went explained, "we found ourselves immersed in smog research as a matter of self-protection. Although chemists are still trying to determine what particular gases in the air constitute smog and discover which or how many are toxic to plants, we have come to the conclusion that smog itself can make the growing of many vegetables in the area economically impossible."

Working with Dr. Went in the plant research are Superintendent G. P. Keyes; Captain Roy Signer; Dr. G. Camus, a botanist from the Sorbonne in Paris; Mr. John Nitsch, a botanist from the French Department of Agriculture; Dr. W. Hiesey of the Carnegie Institution of Washington; and Dr. Albert Ulrich of the University of California; and many others.

Loading Quartz Crystals to Improve Performance

WASHINGTON, D. C.—The erratic performance of piezoelectric plates has long been a problem in the production of oscillator units, and many investigations have been undertaken to determine the causes of instability. Experimental results obtained by Leland T. Sogn of the National Bureau of Standards over the past few years show that it is possible to improve the performance of certain types of thickness-shear quartz plates by coating their surfaces with some inert material. According to NBS Technical Report 1431, two distinct effects have been noted: first, that produced by an amount of the loading material so small that the resultant frequency change is as little as 0.03 percent of the crystal fundamental; and, second, that produced by a much larger mass of the loading material properly distributed over the central area of the crystal. The latter seems to have the beneficial effects now achieved by contouring, a difficult and expensive process. The potential usefulness of loading thin crystals to improve performance as well as to recover plates ground too thin in the production stage should encourage further research on the various aspects of quartz-crystal loading.

A phenomenon associated with a wedge-shaped 0.5 x 0.6-inch BT oscillator plate (width parallel to the *X*-axis) prompted the present investigations. When the electrodes coupling the oscillator plate to the electronic circuit were placed over the thicker portion of the plate, the frequency was not only lower (as anticipated because frequency is inversely proportional to thickness) but the activity was considerably higher, shown by the magnitude of the grid current. Lower frequency was associated with higher activity or amplitude of vibration, and vice versa.

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To investigate this phenomenon a small quarter-inch probe electrode was employed. With this electrode, it was possible to confine the energy fed back from the electronic circuit to a small area of the plate and thereby obtain a series of frequencies and activities as the electrode was moved in short steps from the thick to the thin portion of the plate. In "flat" plates the frequency fluctuated about a mean value as the electrode was moved over the plate surface, and it was found that activity measurements as well as frequency measurements can be used to detect minute differences in thickness which were not disclosed even by instruments sensitive to differences of less than 20 microinches. Activity readings were actually used to check and control the contour of plates during the process of hand-grinding.

In most of the hand-finished plates used in these experiments, positions determining a certain frequency were found to be scattered indiscriminately over the surface although some oscillator plates had contour and edge conditions such that only a few, nearly equal frequencies could be obtained. For example, in an 8.7-Mc. plate with only two frequencies about 5 kc. apart, the frequencies would alternate from one to the other as the electrode was moved across a line roughly parallel to the X-axis, which divided the plate into two approximately equal areas. This plate apparently was composed of two approximately equal flat areas which differed in thickness by the equivalent of a 5-kc. difference in frequency. The balance between the two frequencies was so delicate that a rapid alteration between the two frequencies could be obtained by adjusting the temperature or circuit constants, resulting in an audible "motorboating" effect in the measuring equipment. Changing the length, or Z dimension, by alternately grinding opposite edges (parallel to the X-axis) produced anticipated results. When the edge bounding the thick end of the plate was ground, the higher frequency became dominant because the area of the thin, high-frequency plateau became relatively larger. Subsequent grinding on the other edge reversed the effect: when the thicker area was relatively larger, its lower frequency was dominant. This procedure was repeated several times with identical results.

Experiments were also carried out using machine-lapped convex crystals. Results were similar, but one new fact was disclosed. The lowest frequency, excited when the small electrode was placed at the exact center of the plate, did not give greatest activity. Instead the optimum activity, 50 percent higher, was obtained by moving the electrode to a different position near the center. Shifting to the thinner edges was acompanied by increasing frequency and decreasing activity; moving from the optimum point toward the center caused both activity and frequency to decrease. The area of the crystal and the frequency range over which this anomalous behavior occurred were small. For example, in a 10-Mc. plate which had an edge-to-center frequency variation of 25 kc., the frequency which gave maximum activity was about 5 kc. higher than the lowest frequency obtainable; the electrode position in this case was about one-fifth the distance from the center to the corner of the plate. Typical activity values as indicated by the rectified grid current from the oscillator tube, were 0.5 at the center of the plate, 0.8 at the optimum position on the plate, and 0.2 at the corner.

Temperature runs (−60 to +90 C.) were made on several half-inch-square 10-Mc. plates which had centers about 0.00005 inch concave. All had activities which varied constantly between 0 and 0.2 milliampere over the temperature range, and frequencies which were correspondingly unstable. These oscillator blanks were etched slightly to raise their frequencies 3 to 5 kc., and then were loaded to their original frequency, thereby reestablishing the original relationship between the fundamental and other secondary modes. The loading material was woods metal, applied lightly in a quarter-inch diameter circle concentric with the center of the plate. The effect was a more than three-fold increase in the activity (0.2 to 0.7 ma. or more). Subsequent temperature runs revealed that the increased activity was associated with a general improvement in operating characteristics over the entire temperature range. Also, the resistance at series resonance, R_s, decreased sev-

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*Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.
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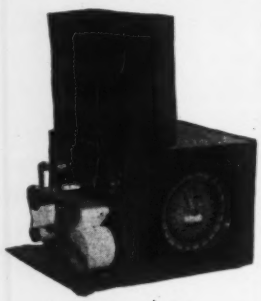

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eral fold while the Q increased correspondingly. Since the same frequency-dimension relationships were maintained, factors other than the usually ascribed coupling phenomena are responsible in some measure for the erratic behavior; perhaps the most important of these is the frequency at which the plate is being driven. In general, it appears that plates whose central active areas have a frequency that is too high for the plate as a whole tend to have poor frequency stability and activity. Elimination of this condition can very easily be effected through a lowering of the frequency by placing a small mass of material upon the central areas.

Loading certain areas of lower-frequency plates very heavily has also been found to be beneficial. It has long been known that giving a slight convexity to some types of oscillator plates results in improved performance Recent experiments indicate that if this contouring takes the form of a plateau at the center with tapering edges, the performance is improved even more.

Several loading materials, both metallic and non-metallic, have been used effectively. Woods metal has certain advantages in hand application because it is soft, adheres well to quartz, and can easily be removed. The amount of metal for satisfactory results varies with the percentage of the area coated as well as with the shape of the coated area. An elliptical pattern with the long axis parallel to the X-axis has good effect, and a band across the plate in the X-axis direction, covering about one-third the area of the plate, is also effective. A narrower band parallel to the X-axis is less effective while similar patterns rotated 90 degrees (long dimensions perpendicular to the X-axis) are still less effective: a narrow band perpendicular to the X-axis appears to have a deleterious effect. In most of the experiments, an equal amount of Woods metal was applied to both faces of a plate. (When the coated area was the size of a pinhead, an interesting effect occurs: the frequency decreases at first, as expected, but further application of metal causes the frequency to jump to a point many kilocycles higher than the original frequency).

A better understanding of the theories involved in quartz-crystal loading and how the most beneficial effects may be produced must await more comprehensive study. A considerable improvement over the hand-loading technique could no doubt be effected through evaporation processes similar to those used for coating mirrors.

Basic Law Creating National Bureau of Standards Extensively Amended

WASHINGTON, D. C.—A new law has been passed by the Congress and signed by the President of the United States defining and describing the authorized functions and activities of the National Bureau of Standards. This law —Public Law 619, 81st Congress, approved July 22, 1950— makes clear and explicit the legal basis for the activities of the National Bureau of Standards. The law is primarily an amendment to Section 2 of the Act of March 3, 1901, which established the Bureau.

The original Section 2 of the 1901 Enabling Act has the following provisions:

> Sec. 2. That the functions of the Bureau shall consist in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere.

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The primary purposes for which the Bureau was established were to provide a basis for accurate measurements in this country and a source of information regarding basic properties of materials determined by such measurements. However, there arose almost immediately occasions for the practical application of these primary services to meet needs of the Government and of industry which were not foreseen, or at least not explicitly mentioned, in the Act. Consequently within a few years the Congress made specific appropriations for activities which could only be covered by a broad interpretation of the clause, "the solution of problems which arise in connection with standards."

Among such activities, testing of materials and supplies purchased by the Government and the preparation of specifications for such materials early became important parts of the Bureau's duties although the Act of 1901 contains no reference to such service. During a period of 25 years beginning in 1910 the Congress provided specific funds for many additional lines of work in the Bureau without making the basic statutory authorization more explicit. These special items were repeated from year to year in appropriation acts up to 1935. Since then annual appropriation acts have specified that the funds provided were intended to cover the functions set forth in detail in the 1935 act. The new law gives explicit legislative authority in place of such reference to an appropriation act based upon interpretations of the Act of 1901.

In accordance with the general policy of giving responsibility to secretaries of departments of the Government, the new act assigns functions to the Secretary of Commerce. The act prescribes six functions in general terms, as follows:

(a) The custody, maintenance, and development of the national standards of measurement, and the provision of means and methods for making measurements consistent with those standards, including the comparison of standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government.

(b) The determination of physical constants and properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere.

(c) The development of methods for testing materials, mechanisms, and structures, and the testing of materials, supplies, and equipment, including items purchased for use of Government departments and independent establishments.

(d) Cooperation with other governmental agencies and with private organizations in the establishment of standard practices, incorporated in codes and specifications.

(e) Advisory service to Government agencies on scientific and technical problems.

(f) Invention and development of devices to serve special needs of the Government.

This general statement of functions of the National Bureau of Standards is supplemented by a more specific list of nineteen activities with the following provisions:

(1) the construction of physical standards;

(2) the testing, calibration, and certification of standards and standard measuring apparatus;

(3 the study and improvement of instruments and methods of measurements;

(4) the investigation and testing of railroad track scales, elevator scales, and other scales used in weighing commodities for interstate shipment;

(5) cooperation with the States in securing uniformity in weights and measures laws and methods of inspection;

(6) the preparation and distribution of standard samples such as those used in checking chemical analyses, temperature, color, viscosity, heat of combustion, and other basic properties of materials; also the preparation and sale or other distribution of standard instruments, apparatus and materials for calibration of measuring equipment;

(7) the development of methods of chemical analysis and synthesis of materials, and the investigation of the properties of rare substances;

(8) the study of methods of producing and of measuring high and low temperatures; and the behavior of materials at high and at low temperatures;

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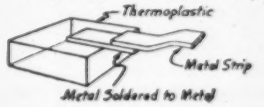

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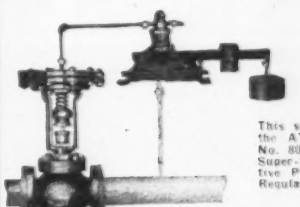

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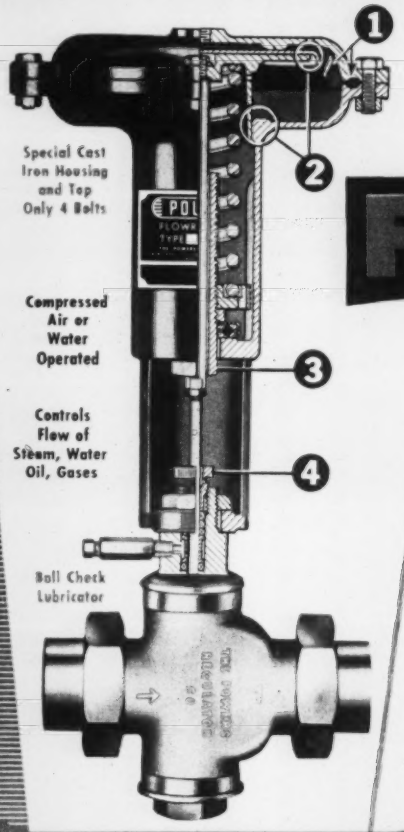

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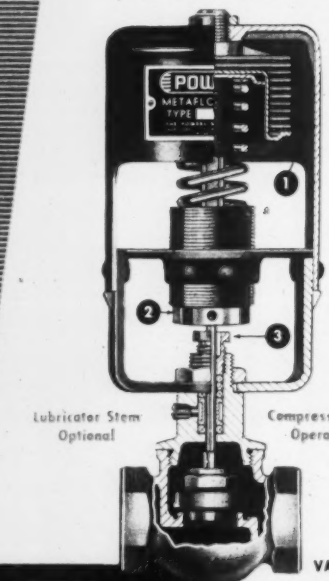

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(15) the determination of properties of building materials and structural elements, and encouragement of their standardization and most effective use, including investigation of fire-resisting properties of building materials and conditions under which they may be most efficiently used, and the standardization of types of appliances for fire prevention;

(16) metallurgical research, including study of alloy steels and light metal alloys; investigation of foundry practice, casting, rolling, and forging; prevention of corrosion of metals and alloys; behavior of bearing metals; and development of standards for metals and sands;

(17) the operation of a laboratory of applied mathematics;

(18) the prosecution of such research in engineering, mathematics, and the physical sciences as may be necessary to obtain basic data pertinent to the functions specified herein; and

(19) the compilation and publication of general scientific and technical data resulting from the performance of the functions specified herein or from other sources when such data are of importance to scientific or manufacturing interests or to the general public, and are not available elsewhere, including demonstration of the results of the Bureau's work by exhibits or otherwise as may be deemed most effective.

Besides these amendments, the new act adds three sections which refer to financial support for the Bureau's work from sources other than direct appropriations:

The Act of March 3, 1901 (31 Stat. 1449), as amended, be, and the same hereby is, further amended by inserting at the end thereof the following sections:

Sec. 11. For all services rendered for other Government agencies by the Secretary in the performance of functions specified herein, the Department of Commerce may be reimbursed in accordance with section 601 of the Economy Act of June 30, 1932.

Sec. 12. In the absence of specific agreement to the contrary, equipment purchased by the Department of Commerce from transferred or advanced funds in order to carry out an investigation authorized herein for another Government agency shall become the property of the Department of Commerce for use in subsequent investigations.

Sec. 13. (a) The Secretary of Commerce is authorized to accept and utilize gifts or bequests of real or personal property for the purpose of aiding and facilitating the work authorized herein.

(b) For the purpose of Federal income, estate, and gift taxes, gifts and bequests accepted by the Secretary of Commerce under the authority of this Act shall be deemed to be gifts and bequests to or for the use of the United States.

In addition to this law, another law—Public Law 618, 81st Congress, approved July 21, 1950—provides authority for certain administrative and operational activities of the Bureau.

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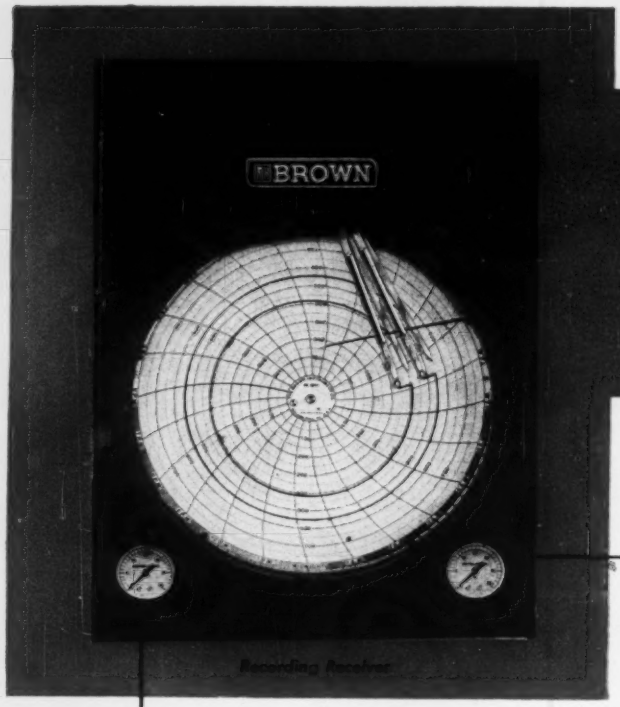

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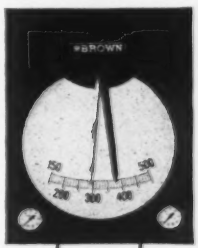

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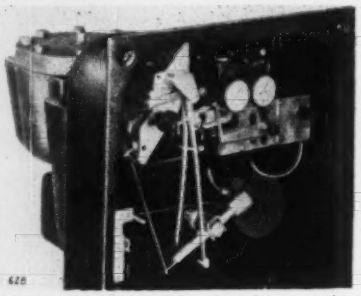
Automatic Flow-rate Controller

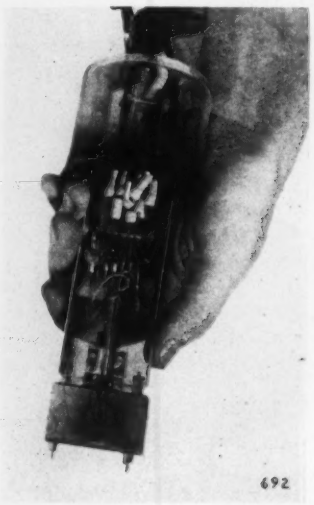
New automatic flow-rate controller has fully adjustable automatic reset, and proportional band adjustable from 0 to 175 percent. Both nozzle and restriction have sapphire jewels; restriction may be cleaned in service. Control mechanism is removable from case. Flow-rate meter features magnetic coupling between float and pen movement.—*Penn Industrial Instrument Corp.*, 3116 *N. 17th St., Philadelphia 32, Penna.*



Mention No. 1201 when filling out card.

Ion Resonance Type Mass Spectrometer Tube

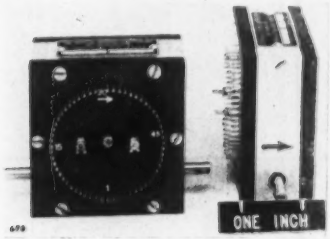
New ion resonance tube forms ions which are accelerated in crossed magnetic and r-f. electric fields. Ions describe spiral paths and those with proper mass to resonate with crossed fields gain energy and describe larger and larger orbits until they reach collector and are measured. It is expected that resolution up to mass 100 can be achieved. Approx. 150 v. d.c. and 1 v. at frequencies up to 5 Mc. are employed. Filament uses 5 amp. at 15 watts. Tube has glass envelope and requires magnet with 1 in. gap and field strength of several thousand gauss. Tube can be mounted in any position.—*General Electric Co., Schenectady 5, N. Y.*



Mention No. 1202 when filling out card.

High-speed Multichannel Sampling Switch

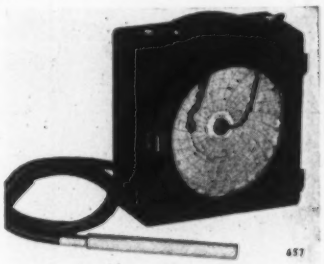
New "Model 2-60S-L" switch has a 60:1 internal gear reduction and 2 poles, each containing 60 contacts. Two synchronized wipers can sample contacts at a rate of one per revolution of input shaft, thereby permitting user to correlate data from different channels with respect to angular position from a fixed reference for drive shaft. Shorting-type wipers make possible up to 60 independent channels per pole for make-before-break switching; up to 30 per pole for break-before-make when alternate contacts are unwired.—*Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.*



Mention No. 1204 when filling out card.

Portable Temperature Recorder

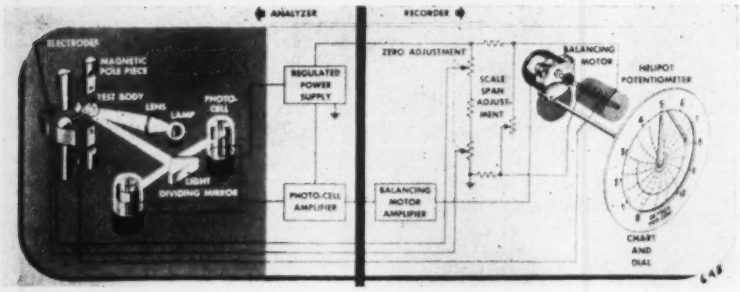
New "Minicorder" is a self-contained recording thermometer with ranges from -30 F. to 165 F. Charts are available for 24 hr., and 3 and 7 day rotation. Two-pen models are made for on-off recording of related electrical equipment. Instrument measure 6x6x4 in., weighs 3.5 lbs.—*TAGliabue Instruments Div., Weston Electrical Instruments Corp., 614 Frelinghuysen Ave., Newark 5, N. J.*



Mention No. 1205 when filling out card.

Oxygen Analyer

New analyzer is based on paramagnetic property of oxygen. Rotation of test body in permanent magnetic field is caused by changes of oxygen concentration in analyzer. Reflecting mirror divides light beam unequally between photocells, creating electrical potential which is amplified and indicated on a recording potentiometer. Measurement range covers parts per million to 100 percent oxygen. Accuracy is 1 percent of scale span for ranges of 0-5 percent and greater, and 0.02 percent oxygen for 1 percent scale span at any concentration.—*A. O. Beckman, Inc., 11 W. State St., Pasadena 2, Calif.*



Mention No. 1203 when filling out card.

Automatic Analyzer for Low Temperature Distillation

New automatic analyzer operates in temperature range of -200 to 100 C, pressure range of 1 to 760 mm. Hg abs. Unit has a charge capacity of 0.5 to 100 cc., and an accuracy of 0.5 percent. Temperature recorder has second range, 0-2 mv., for increased sensi-

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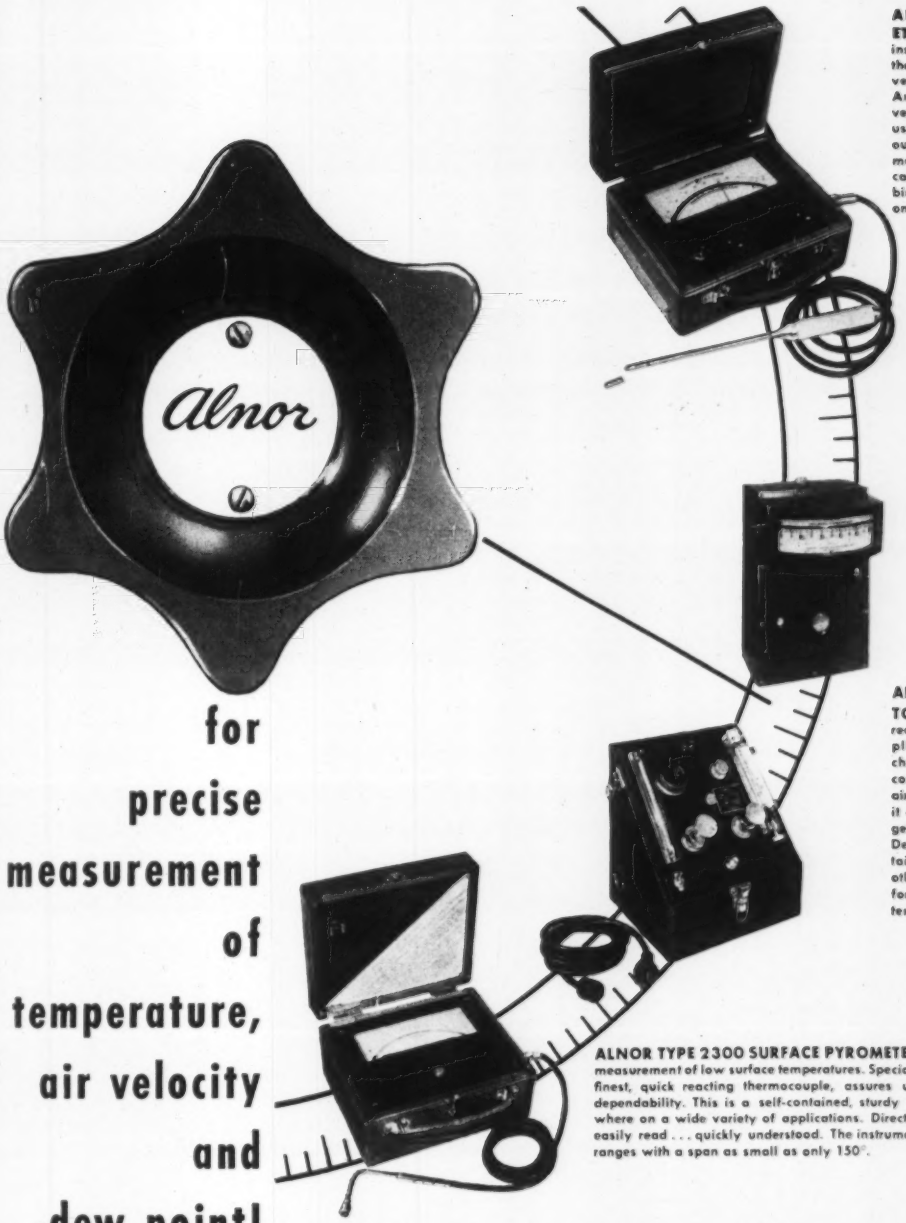

ALNOR THERMO-ANEMOMETER Here's a compact, direct-reading instrument that fills a long-felt need—the accurate measurement of low air velocities. With the Alnor Thermo-Anemometer you can accurately read velocities as low as 5 f.p.m. It can be used between 20°F. and 150°F. without impairing its accuracy. Fine craftsmanship, high-quality materials, exact calibration, and exhaustive tests combine to assure you accurate operation on a wide variety of applications.

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ALNOR TYPE 2300 SURFACE PYROMETER . . . sets a new high in precision measurement of low surface temperatures. Special design, from Alnico magnet to the finest, quick reacting thermocouple, assures unfailing accuracy . . . speed and dependability. This is a self-contained, sturdy unit—easily carried and used anywhere on a wide variety of applications. Direct reading, six-inch mirrored scale is easily read . . . quickly understood. The instrument is available in 5 Fahrenheit scale ranges with a span as small as only 150°.

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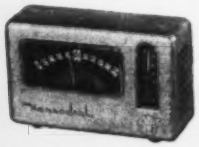

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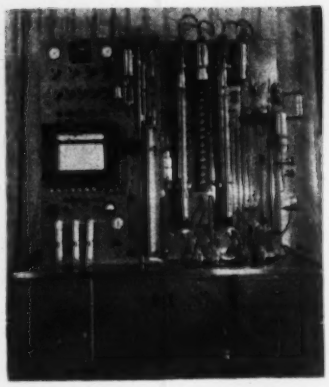
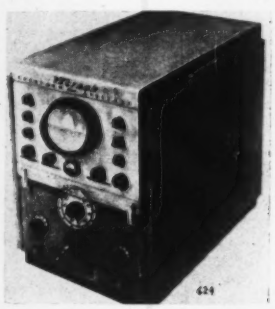


tivity. New column has higher throughput rate, more plates, with no increase in holdup. Tubular thermocouple assembly reduces holdup in reflux section; entering gas rates are indicated by rotameter. All stopcock manifold and connecting lines are stainless steel.—*Podbielniak, Inc.*, 341 *E. Ohio St., Chicago* 11, *Ill.*

Mention No. 1206 when filling out card.

Microwave Spectrum Analyzer

New "Vectron" spectrum analyzer, covering S and X bands, features interchangeable r-f. heads that provide coverage of microwave spectrum to

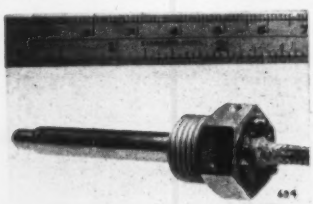


30,000 Mc. Housing incorporates a 5 in. c-r. tube, with a mounting that permits use of a 35 mm. camera.—*Dep't SA., Robert A. Waters, Inc.*, 4 *Gordon St., Waltham* 54, *Mass.*

Mention No. 1207 when filling out card.

Resistance-thermometer Bulbs

New "Type 19" element consists of a platinum winding contained between concentric cylinders, and located 0.25 in. from end of bulb. Resistance changes

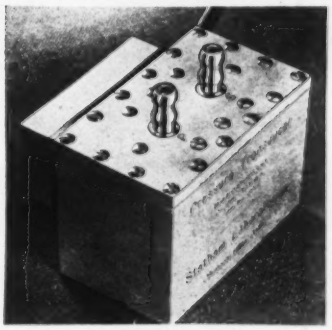


6.2 ohms over temperature range of instrument. Thermometer has a thermal time constant of 1.8 seconds in water. Bulbs are suitable for use to 2000 F., 12,000 psi.—*Trans-Sonics, Inc., Bedford Airport, Bedford, Mass.*

Mention No. 1208 when filling out card

Dynamically-balanced Pressure Pickup

New "Model P69" pressure pickup has an acceleration response less than 0.1 percent of full scale per G up to 10G in any axis. Unit is temperature-compensated over the range −65 F. to



250 F.; measures gage or differential pressure in ranges 0-1 to 0-20 psi., and absolute pressure from 0-15 psia. It has a high natural frequency.—*Statham Laboratories, Inc.*, 9328 *Santa Monica Blvd., Beverly Hills, Calif.*

Mention No. 1209 when filling out card.

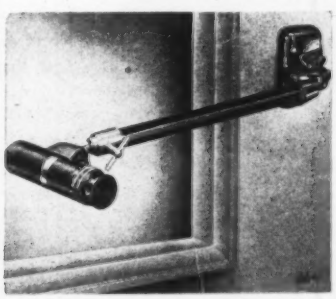
Automatic Temperature Controller

New "Type 218" proportioning controller will throttle 100 watts at 110 v. 60 cps.; is said to maintain oven temperature within 0.1 C. up to 1000 C. Temperature setting is by dial on front panel. Unit is 8 x 9 x 12 in.—*W. S. MacDonald Co., Inc.*, 33 *University Road, Cambridge* 38, *Mass.*

Mention No. 1210 when filling out card.

Instrument-reading Telescope

New prismatic scope in combination with a universal mounting bracket is used for observing distant water columns, gages, and laboratory instruments. Magnification permits water



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columns to be read at more than 100 ft. with good visibility and wide field view. Bracket holds telescope steady, but permits readjustment to any angle. —*Kollmorgen Optical Corp., 2 Franklin Ave., Brooklyn* 11, *N. Y.*

Mention No. 1211 when filling out card.

Triplet Magnifier

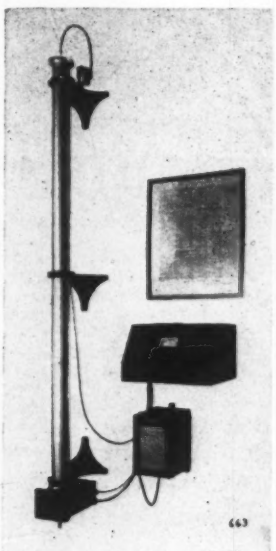
New "Model S-171" magnifier consists of three elements cemented together, for correcting chromatic and

spherical aberrations. Field of view is 0.75 in. and focal length is 1 in.—*Buhl Optical Co., Dept., TI-8.* 1009 *Beech Avenue, Pittsburgh* 12, *Penna.*

Mention No. 1212 when filling out card.

Particle-size Analyzer

New "Micromerograph" measures particle size distribution of a powdered material in sub-sieve range. Powder sample is deagglomerated at top of an

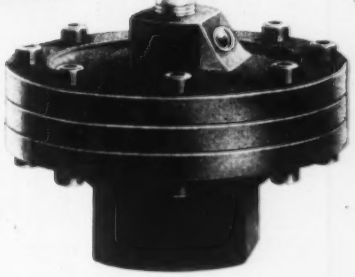


enclosed tube by firing it at high velocity through an adjustable aperture, and particles are allowed to settle onto a balance pan. Balance is a fast-response, type which yields a continuous record of weight of powder settled plotted against time. Chart is converted to a weight distribution curve by application of Stokes' law. Instrument

HELICOID
Chemical Gage

Standard dials: 0-15, 30, 60, 100, 150, 200, 300, 400, 500, 600, 800, 1000, 1500, 2000, 3000. Also 0-30" vac., 15 and vac., 30 and vac., 60 and vac.

Supplied with Cartridge Snubber in socket for pump service.



Bronze
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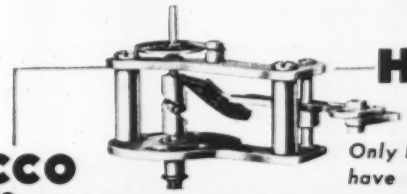
Lead Coated Iron
Steel
Stainless Steel (316)
Monel
Hastelloy B
Hastelloy C
Dural (24 S-T)
Carpenter No. 20 (Duramet)
Nickel
Everdur
Hard Rubber

● Here's a chemical gage for any pressure to 3,000 p.s.i. and also for vacuum or compound ranges, and temperatures to 300° F. Particularly suitable for chemicals and other viscous liquids that either corrode or clog a Bourbon tube gage.

One feature of this Chemical Gage is that the diaphragm is made of "TEFLON" which is flexible and resists practically all corrosive chemicals. No fragile metal foils are used. The diaphragm chamber is supplied of any metal most suitable for the service.

Available in the following dial sizes: 4½", 6", or 8½". 1" female N.P.T. bottom connection. Flanged connection also supplied.



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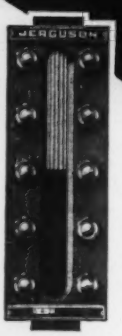

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YOU can get Clearest Visibility over a long period of time with Jerguson Gages, for Jerguson is now coating all gage glasses with a new special compound that maintains improved visibility.

Jerguson gage glasses are far superior with this new treatment. They are far less subject to fouling through foreign matter adhering to the glass; and viscous liquids are largely prevented from hanging up, thus greatly improving the observation of the true liquid level. You get the advantage of another "First" in a long series of advancements by Jerguson.

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All gaskets are treated with a special compound which *prevents adhesion to glass or metal* under high pressure or high temperature. Glass and gasket replacements are easily made without damaging seats through scraping.

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is recommended for materials having particles in range of 2 to 150 microns, but exact operating limits depend on density of material, allowable time of analysis, and precision required.—*The Sharples Corp., 23rd and Westmoreland Sts., Philadelphia 40, Penna.*

Mention No. 1213 when filling out card.

Schmidt Optical Barrel

New Schmidt optical barrel is available for projection of TV, radar, and

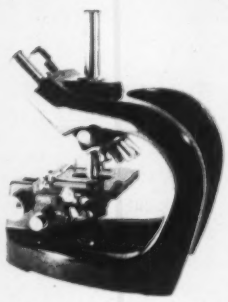
675

CRO images on screens up to 6 x 8 ft. Image size may be varied by a control on barrel.—*Spellman Television Corp., 3029 Webster Ave., Bronx 67, N. Y.*

Mention No. 1214 when filling out card.

Combination Monocular and Binocular Microscope

New "Microbe Hunter" provides monocular and binocular observation through one optical system. Photographic equipment is mounted on monocular tube; a turn of a knob permits



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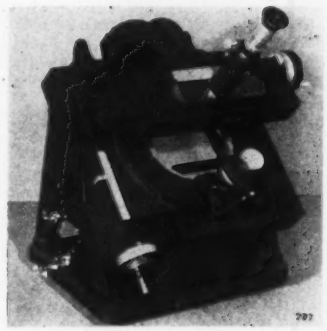
binocular observation until picture is taken. Focusing adjustments on base do not carry weight of optical parts. Nosepiece provides for six objectives. A built-in spherical lamp attaches directly to mirror support. Mechanical stage moves 60 mm. sideways and 40 mm. forward and backward; a vernier scale reads to 0.1 mm.—*International Microscope and Art Co., 1670 W. Ogden Ave., Chicago 12, Ill.*

Mention No. 1215 when filling out card.

Coordinate Comparator

New "Model M1229" coordinate comparator is used for coordinate and angular measurements on 3.25 x 4.25 in. photographic plates. Longitudinal



707

measurements carry microscope over range of 100 mm.; transverse measurements move stage in range of 80 mm. Both motions are by precision micrometer screws, each with correction bar, reading to 0.001 mm. In addition, stage rotates through 360 deg., read to 0.01 deg. Microscope, inclined at 45 deg., has a magnification adjustable from 1X to 40X. It is normally equipped with 60 deg. cross hairs. Substage illumination is provided by adjustable mirror and diffusion glass in base.—*Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.*

Mention No. 1216 when filling out card.

Portable 85-degree Glossmeter

New "Items P32 to P35" are portable instruments for measuring specular gloss according to Method 611.1, Federal Spec. TT-P-141b. Instrument consists of an exposure head with lamp, lens, and light meter. Power supply may be either transformer or battery.—*Henry A. Gardner Laboratory, Inc., 4723 Elm St., Bethesda, Md.*

Mention No. 1217 when filling out card.

Autopilot for Executive and Light Planes

New "L-2" autopilot operates from panel-mounted gyro, through an amplifier, and positions servos connected to plane's control surfaces to maintain level flight. Instrument is also a maneuvering pilot, capable of coordinated turns and climbs. A button mounted on control wheel disengages automatic operation, and slip clutches allow pilot to over-ride mechanism if necessary. Unit weighs 30 lbs.—*Lear, Inc., 110 Ionia Ave. NW., Grand Rapids, Mich.*

Mention No. 1218 when filling out card.

Linear Comparator

New "Model M1205C" linear comparator for absolute measurements on spectrum plates or other flat objects has a range of 255 mm. and is direct reading to 0.001 mm. Variable power viewing microscope contains a roof prism to bend optical axis to a position convenient for observer and to erect image, giving it normal left-right orientation. Stage is intended for 4 x 10-in. plates but there are no obstructions to limit

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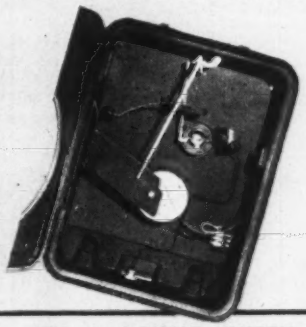
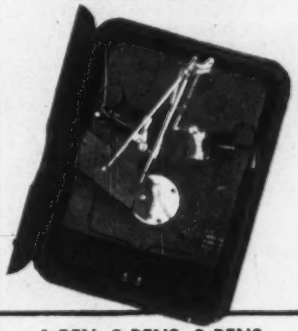
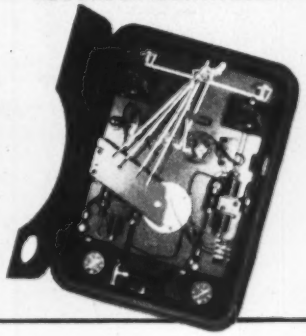


IT'S A PRESSURE RECORDER!

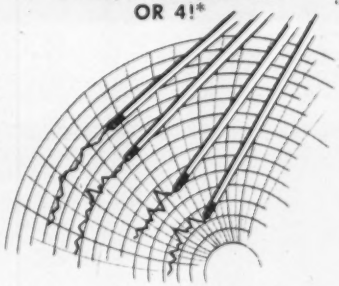


IT'S A SINGLE PEN RECORDER-CONTROLLER!

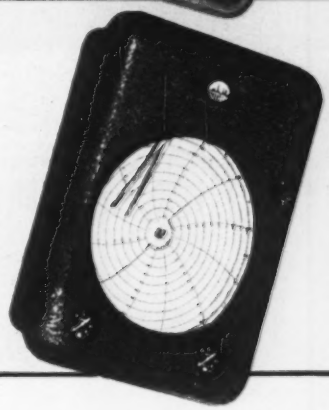
IT'S A DOUBLE SYSTEM RECORDER-CONTROLLER!



1 PEN, 2 PENS, 3 PENS OR 4!*



*4 pens on 12" recorder. Limit on 9" recorder —2 pens, on 6" recorder—1 pen.



You have never seen any recorder quite like the Gotham CONVERTIBLE. For here is one precision instrument that is as flexible as an eel. And a miser for maintenance. Read why!

The basic elements of the recorder, that is, the tube system, clock mechanism, and translating movement, are the same for 6", 9" and 12" chart size recorders. Temperature and pressure systems are completely interchangeable. Functions up to 4 pens can be added (to the 12" size) in a twinkling. Control through air relay or solenoid can also be easily added. For none of these changes, additions, or replacements, however, does any Gotham Convertible have to be returned to the factory.

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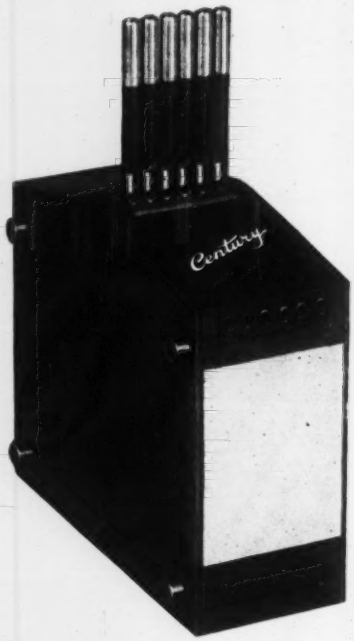

The Century Model 210 Galvanometer has been designed and tested for the utmost in performance under any conditions. The unique small tubular type construction permits their installation in practically any type or make of photographic recording oscillographs. These galvanometers are offered at low cost over a wide range of frequencies and sensitivities to satisfy most recording requirements. For additional information, write for our Catalog No. CGC 206.

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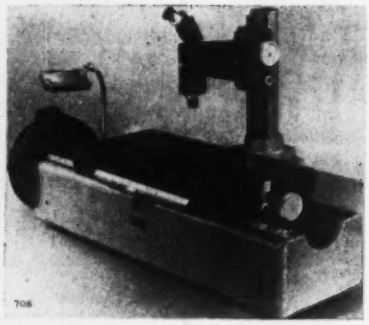


length of plate. Substage illumination is provided by light from external source entering from rear and reflected upward by adjustable mirror. Readings are taken from divided drum and revolution counter at left end of instrument.—*Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.*

Mention No. 1219 when filling out card.

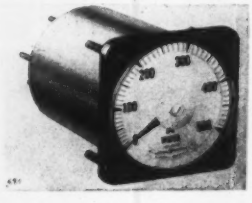
Automatic Colorimeter for Cotton

New colorimeter records simultaneous values of reflectance and yellowness of cotton samples. Instrument is based on maker's "Color and Color-difference Meter," replacing manual balancing with electronic amplifiers and servomotors.—*Henry A. Gardner Laboratory, Inc., 4723 Elm St., Bethesda, Md.*

Mention No. 1220 when filling out card.

Electrical Indicating Instruments

New "Types AB-18 (a.c.) and DB-18 (d.c.)," instruments employ a protruding convex-type glass cover that permits scale to be mounted flush with

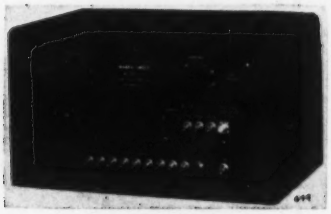


front of case, while providing clearance for moving parts. Jewels are spring-mounted to protect pivot points from shock. Magnetic damping provides quick response and permanency of characteristics. Instruments are 4.25 in. diameter. An a-c. wattmeter is illustrated.—*Meter and Instrument Div., General Electric Co., Schenectady, 5, N. Y.*

Mention No. 1221 when filling out card.

Sweep and Marker Generator

New "Marka-Sweep, Model IF" has a three-position selector switch for 20-30, 30-40, or 40-50 Mc. ranges with overlap. Sweep width is 15 Mc. All



carriers are oscillator fundamentals, and instrument produces a true zero amplitude reference baseline on oscilloscope display. Output level may be varied between 50 microvolts and 250 mv. across 70 ohm unbalanced output. A panel switch narrows and recenters sweep for sound channel measurements. Up to 9 narrow, crystal-positioned, pip-type, markers are available at specified IF frequencies, with on-off control for each mark. Instrument has regulated power supply.—*Kay Electric Co., Pine Brook, N. J.*

Mention No. 1222 when filling out card.

Marker Generator

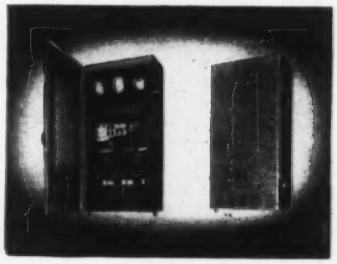
New "Type 501" marker generator provides frequencies from 15 to 240 Mc. in four bands. A fixed-frequency oscillator, with plug-in crystals, pro-

vides check points at fundamental frequencies from 2-20 Mc., and has useful harmonic output up to sixth for band calibration. Instrument is supplied in steel case, over-all dimensions 11 x 8.375 x 7 in.; operation is from 115 v. 60 cps. line.—*Radio Tube Div., Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.*

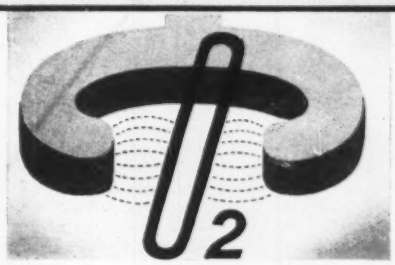
Mention No. 1223 when filling out card.

Electronic Rectifier Units

New floor- or wall-mounted electronic rectifier units are available with constant or adustable d-c. output voltages, in ratings as high as 230 volts, 87 amperes. Adjustable-voltage units provide a range of 60 to 100 percent



Six Reasons Why HAYS = O_2 LEADERSHIP!

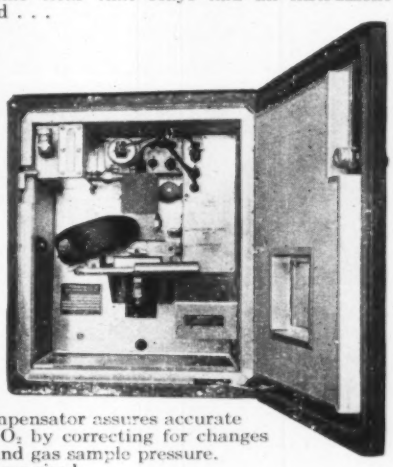


1 HAYS WAS ONE OF THE FIRST TO RECOGNIZE AND APPLY THE PARAMAGNETIC PRINCIPLE

As early as 1909, Joseph Hays recognized the need for an Oxygen Recorder. Thirty years and five oxygen analyzing instruments later, Hays research engineers had a principle worth complete exploitation—the paramagnetic qualities of oxygen. Then followed . . .

2 MONTHS OF CONTINUOUS LABORATORY RESEARCH

Once it had been established that magnetically induced thermal resistance changes accurately mirrored O_2 content changes in a gas sample, millionfold amplification was required. Existing amplifiers proved inadequate, so Hays designed their own. When their Analyzer and Recorder were completed, it became clear that Hays had an instrument with unequalled . . .



3 PRACTICAL DESIGN FEATURES

Positive, instant zero check through free swinging magnet. High sensitivity, rapid response to O_2 changes—rugged construction.

Patented compensator assures accurate readings in % O_2 by correcting for changes in barometric and gas sample pressure.

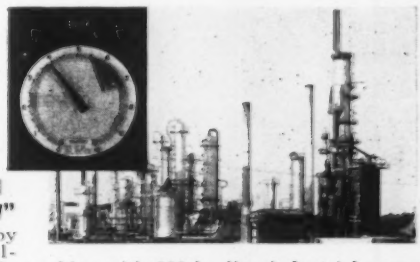
No chemical required . . .
No combustion . . . complete safety
No gaseous or liquid fuels added to gas sample
Provision for 4 records on one chart

4 PAINSTAKING, PRECISION FABRICATION

High accuracy and sensitivity require close tolerances—production problems arose. Hays solved these problems by investing large sums in new machines, by building their own equipment not available elsewhere, by using their 40 years of instrument manufacturing "know-how." When finished, the new O_2 Recorders were subjected to . . .

5 FOUR YEARS OF INTENSIVE FIELD RESEARCH

Test installations were made in the oil, steel and glass industries; power plants, and laboratories. Instrument performance was noted under varying conditions, findings were then translated into product improvements. New compensations, calibrating techniques and adjustments were developed, giving Hays a wealth of . . .



6 APPLICATION "KNOW-HOW"

You benefit by Hays knowledge gained in working with 200 leading industrial users . . . experience in applying the Magno-Thermo O_2 Recorder to Catalyst regenerators, process heaters, heat treating furnaces, open hearths, government laboratories and similar operations.

BULLETIN 49-829 free for the asking, describes the principle and operation of this instrument . . . write for it!

The Hays CORPORATION
MICHIGAN CITY, INDIANA, U. S. A.

THE HAYS CORPORATION
Michigan City 8, Indiana

Please send me Bulletin 49-829 which describes the Hays Oxygen Recorder and Analyzer

Name _____

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PRINCO'S Magnetic Thermoregulator

ADJUSTS EASILY to .005°C!

FINE ADJUSTMENT

Contact electrode is positioned quickly within .005°C by means of movable external magnet.

ROUGH ADJUSTMENT

Mercury overflow chamber permits easy approximation to desired temperature setting

PRINCO "MAGNA-SET"* THERMOREGULATOR

Brings new accuracy, sensitivity and ease of adjustment to the field of variable temperature controls. May be expected to control a well-agitated, constant-temperature bath of correct design to within ±0.02°C. Available in ranges from −35°C to +300°C, or −60°C to −35°C. Ask for Bulletin "T" which also lists a complete line of electronic and magnetic relays.

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1437 BRANDYWINE STREET PHILADELPHIA 30, PENNA.

of rated output voltage. All components are mounted in factory-assembled enclosures, are rated conservatively. Separate compensating adjustments for filament voltages are incorporated in all models, which are designed for operation from 115/230 or 230/460 volts, single-phase or three-phase.—*Westinghouse Electric Corp., Box* 2099, *Pittsburgh* 30, *Penn.*

Mention No. 1224 when filling out card.

Multi-purpose Electrical Tester

New "MV-73B" multi-meter has full scale sensitivity of 10 mv. for d-c. and a-c. measurements, and a maximum sensitivity of 25 mv. for full scale, up

to 300 Mc. Scale ranges cover from 1 microamp. to 10 amp., 10 mv. to 1000 v. Ohmmeter circuit is fed from regulated power supply.—*Millivac Instrument Corp., P. O. Box* 3027, *New Haven, Conn.*

Mention No. 1225 when filling out card.

Insulation Tester

New "Current Limited High-potential Tester" operates from power supply of 105 to 125 v. 60 cps.; is available in either single or dual range models. Single range is 0 to 3200 v. rms, second range is 0 to 1600 v. Primary circuit

uses resistance and a potential divider to supply an adjustable voltage to transformer and to damp out line surges. Faults are indicated by a glow lamp on panel.—*Special Products Div., General Electric Co., Schenectady* 5, *N. Y.*

Mention No. 1226 when filling out card.

Mixer Crystal Test Set

New "Type 390" portable self-contained mixer crystal test set, for measuring conversion loss and noise temperature of silicon crystals, is particularly suitable for production testing, incoming inspection, and field tests. It has a correlation accuracy of plus or minus 0.5 db on conversion loss measurements and 0.5 on noise temperature mean deviation. It is intended for use at or below 10,000 Mc. for direct indication and above 10,000 Mc. for relative indication.—*Airborne Instruments Laboratory,* 160 *Old Country Road, Mineola, N. Y.*

Mention No. 1227 when filling out card.

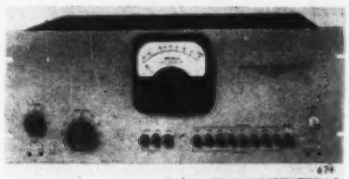
Plug-in Line Amplifier

New "Type MI-12160" line amplifier provides frequency response from 30 to 15,000 cps. It features inverse feedback control and voltage-regulated power supply, and has a rated power output up to two watts. An interstage gain control with positions 0 to 10 is mounted on front apron. Self-contained power supply consists of power transformer, high-vacuum full-wave rectifier tube, and output filter. Unit draws 75 watts from 105-125 v. 50-60 cps. power supply. Overall dimensions 5 x 13 x 7 in., weight 11 lbs.—*Sound Products Section, RCA Victor, Camden, N. J.*

Mention No. 1228 when filling out card.

Noise and Distortion Measuring Set

New "Type 35-A" distortion and noise measuring set comprises eight fixed-band rejection filters covering 50 cps. to 15 kc., followed by a stable,



wide-range, high gain amplifier. Each filter rejects uniformly a band 3 percent of indicated frequency, and passes uniformly harmonics of this frequency. Two amplifier gain controls are provided—one covering 40 to −60 in steps of 10 db, second a continuously variable control covering 10 db. A calibrating voltage is provided internally for accurately adjusting meter to read dbm. Range of noise and distortion that can be measured depends upon level of source being investigated. At a level of −15 dbm the limit is 60 db below or 0.1 percent distortion. Amplifier output is protected by an electronic limiter. Output jacks are provided for connecting an external scope in place of output meter.—*Dacco Co.,* 191 *Central Ave., Newark* 4, *N. J.*

Mention No. 1229 when filling out card.

C-r. Oscillograph

New "Type 303" provides time calibration for horizontal sweep and regulated voltage calibration for vertical deflection. Both are accomplished by substituting a calibrating signal for input signal. Y axis, provides a sensitivity of 0.1 v. peak-to-peak per in. Frequency response is down 3 db at 10

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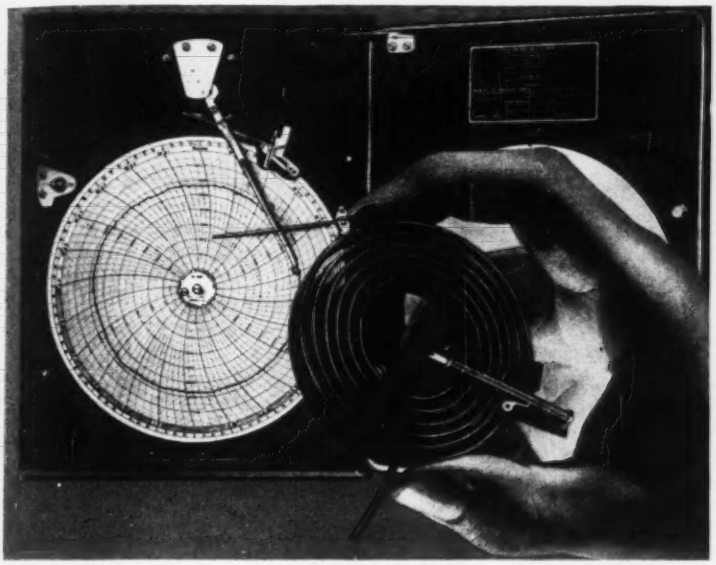
This Tube That Measures Pressure May Solve Your Production Problems



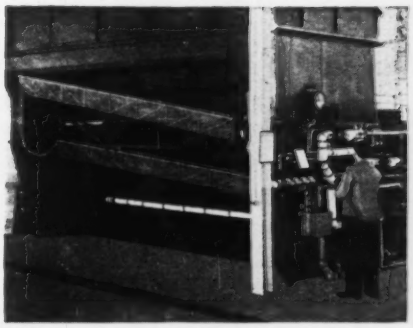
(Photograph courtesy Minneapolis-Honeywell Regulator Company *Brown Instruments Division*)

● Spiral pressure elements—a series of Bourdon tubes joined end-to-end and wound as a flat spiral—measure the pressure in virtually all the pressure gauges and controllers in the 15 to 4000 psig range, made by the Minneapolis-Honeywell Regulator Company, the *Brown Instruments Division*.

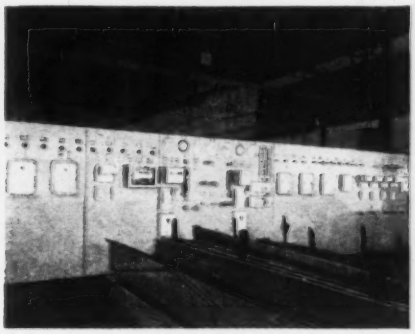
These tubes are a superior product—precise in cross section, dimension, metallurgical and chemical analysis, free from defects in grain structure and surface, unvarying in fatigue life . . . the finest tubes available to do this specific job. They are precision drawn by Superior Tube Company.

And this may be the answer to your tubing problems . . . for just as Superior worked closely with Brown to develop the tubing used in these flat spirals, so they are ready and eager to assist you in the development of a tube to do the specific job demanded by your product or process and do that job better.

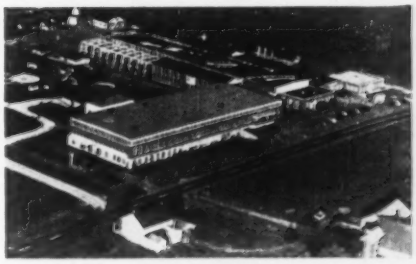
Superior is always ready to furnish tubing for all instrument applications, pressure gauges, controllers, regulators, temperature instruments, etc. For more information, and the name of your nearest Superior distributor, write Superior Tube Company, 2014 Germantown Ave., Norristown, Penna.



To guard against contamination by processing lubricants, the tubing is thoroughly degreased before each annealing operation.



Bright annealing and heat treating furnaces, with instrumentation for control, assure uniform structure, a clean, smooth surface and precise temper tolerances.



Space and Time—133,000 square feet—over 4 acres—for developing, producing, and testing small tubing . . . plenty of space . . . and people who take time to give you a good product and good service.

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SEAMLESS . . . ? The finest tubes that can be made. In all O.D.'s from 1⅜" and lower. Excellent for forming, bending, machining, etc., carbon, alloy, stainless, non-ferrous and glass sealing alloys.

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Bendix-Pacific telemetering facilities can provide you with any phase of a complete instrumentation service. These include:

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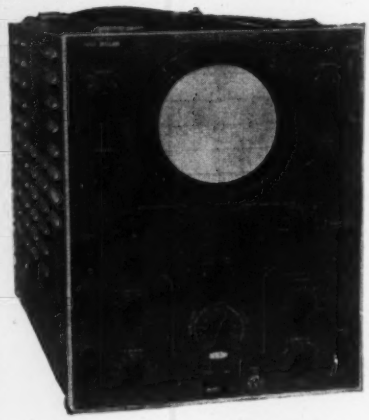
TO MEASURE—TO INDICATE—TO WARN AT A DISTANCE



Mc. with no positive slope in high-frequency range; unit will synchronize stably on signals higher than 15 Mc. Transient response of Y axis is such that a pulse having a rise time of 0.01 microsecond or faster will be reproduced with a rise time not exceeding 0.03 microsecond. Both driven and recurrent sweeps are variable continuously from 0.1 second to 5 microseconds. Sweep length may be expanded to equivalent of 30 in.; Y axis amplifier provides 2.5 in. deflection of unidirectional pulses, or equivalent five in. for symmetrical signals.—*Allen B. DuMont Labs, Inc.*, 1000 *Main Ave., Clifton, N. J.*

Mention No. 1230 when filling out card.

Five-inch Oscilloscope

New "Model T-601-A" has 17 tubes including 5-in. c-r. tube. Instrument has 10 mv. sensitivity, with 12 Mc. band width. Deflection plates are available on terminal board; built-in signal

calibrator is continuously variable from 0-10 v. Sweep can be expanded 5 times full scale. Unit is 14 x 10 x 17 in., weighs 45-lbs.—*Television Equipment Corp., 238 William St., New York 7, N. Y.*

Mention No. 1231 when filling out card.

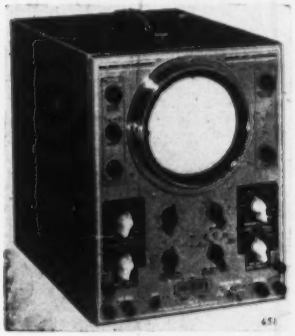
Seven-inch Oscilloscope

New "Type 132Z" oscilloscope has Y-axis sensitivity of 0.1 v. rms for 1 in. peak-to-peak deflection; frequency response flat to 70 kc. Horizontal amplifier provides sensitivity of 0.25 v. rms for 1 in. peak-to-peak deflection; frequency response to 120 kc. Both amplifiers have input impedances of 1.5 megohm and 34 uuf. Linear sweep from 10 to 30 kc. may be synchronized to 60 cps., or an external signal. Over-all dimensions 17 x 11.375 x 17.75 in., weight 39 lbs.—*Radio Tube Div., Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.*

Mention No. 1232 when filling out card.

C-r. Oscilloscope

New "Model CRO-2" oscilloscope uses 5 in. 5UP1 tube. Vertical amplifier response is uniform from 20cps. to 4.5MC. Vertical input impedance is 1.5 megohms, shunted by 20 uuf; horizontal input impedance is 1.1 megohms. Volt-

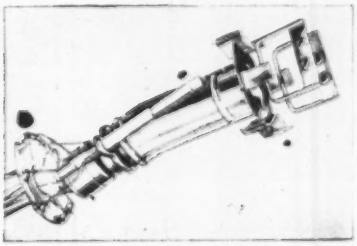


age calibration permits peak-to-peak calibration of all waveforms. Switching arrangement provides vertical pattern reversal. Sweep oscillator provides saw-tooth wave, 20cps. to 50kc. in 5 steps; 60 cps. sinoidal sweep also available. All-steel cabinet measures 13x10.5x15 in., weighs 26 lbs.—*Jackson Electrical Instrument Co., 18 S. Patterson Blvd., Dayton 1, Ohio.*

Mention No. 1233 when filling out card.

Bent Gun for CRO's

New "Bent-Gun" features a higher degree of pre-focusing, without increasing the over-all length of tube. An improved bulb spacer simplifies



electron-gun centering and insures proper anode contact. Stray emission at higher voltages is minimized by rounding corners of pertinent electron-gun components.—*Cathode-ray Tube Div., Allen B. DuMont Labs., Inc., 750 Bloomfield Ave., Clifton, N. J.*

Mention No. 1234 when filling out card.

CRO Marker

New "Model 1-U Labmarker" converts a sinoidal input of up to 30 v. rms into a series of sharp unidirectional

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For locating and measuring leaks wherever pressure or vacuum is used

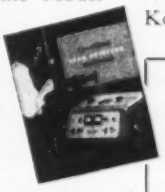
THE CONSOLIDATED MODEL 24-101A LEAK DETECTOR

TO prove absence of any leak, or to detect, locate, and measure rate of leakage in pressure or high vacuum systems, glass to metal seals in electronic equipment, valves, welded or soldered joints—these are only a few of many uses for this versatile instrument.

Employing helium gas and the mass spectrometer principle, this highly sensitive machine responds to leak rates, from atmosphere into an evacuated system, as low as 10^{-9} cubic centimeters per second.

Ruggedly built and mounted on casters for portability, the unit can be moved anywhere for testing systems by "probe" or "envelope" methods, or locating leaks in buried gas lines.

Both visual and audible indicators are standard features on the Model 24-101A.



Send for our free, 16-page bulletin describing the many features of the Consolidated Model 24-101A Leak Detector. It also explains applications and methods, and gives complete specifications. For your free copy, write: Vacuum Equipment Department, ***Distillation Products Industries,*** 765 Ridge Road West, Rochester 3, N.Y. (Division of Eastman Kodak Company).

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THE NEW
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Weight—5½ Ounces • Watts—40 or 60 • Tip Dia.—Both ⅛" and ¼" Tips Furnished with Each Iron • Price— $5.50

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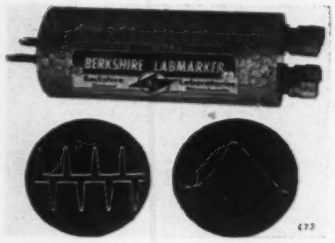
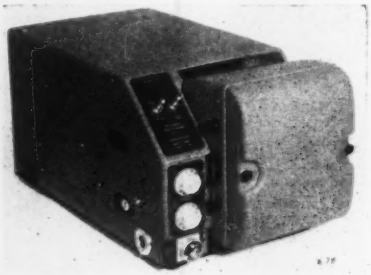


pulses, either positive, negative, or both at once. Approximate characteristics are: pulse duration, one-third of cycle; pulse amplitude, one-half rms input voltage; frequency range, 25 cps. to 1 Mc. Oscillograms show output wave forms of Model 1-U and a record timed with instrument. Labmarker was connected to "Z" axis terminals of CRO to produce short breaks in trace.—*Berkshire Laboratories, P. O. Box 70 I, Concord, Mass.*

Mention No. 1235 when filling out card.

Oscillograph

New "Type 5-116" recording oscillograph is available in 9- or 14-record capacity, for 24-28 v.d.c. or 115 v. 60 cps. drive. Feed magazine provides 125 ft. of recording material, with speeds from 0.25 to 100 in. per second. Instrument uses maker's "Series 7-200" galvanometers, with a prefocused lamp.

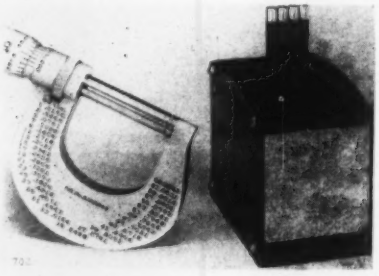


One counter is used for both record-numbering system, and visual indication. All components are mounted on two main castings.—*Consolidated Engineering Corp., 620 No. Lake Ave., Pasadena 4, Calif.*

Mention No. 1236 when filling out card.

Oscillograph Galvanometer

New "Model 102" galvanometer requires 16.1 ma. for 1 in. deflection at 15 in. in 2000-cps. model and 0.008 ma. for 1 in. deflection in 100-cps. model. Instrument is available with undamped natural frequency from 50 to 5000 cps. It is adapted to any type of oscillograph; is available in magnetic structures up to 50 traces. Elements are 0.125 in. diameter and 2 in. long; an eighteen trace model weighs 3.5 lbs. Standard elements have balance displacement of 0.03 in. per G.—*Midwestern Geophysical Laboratory, Tulsa, Okla.*



Mention No. 1237 when filling out card.

D-p. D-t. Choppers

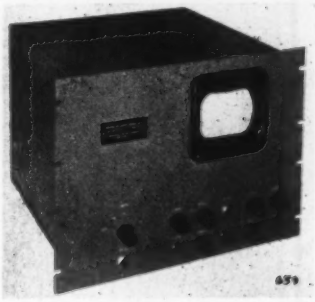
New "Types 252/258" are improved models of maker's d-p.d-t. d.c.-a.c. choppers. Time "ON" can be factory

adjusted in range of 25 to 125 percent. Drive coil operates on 6.v. 45-65 cps.—*Stevens-Arnold, Inc., 22 Elkins St., South Boston 27, Mass.*

Mention No. 1238 when filling out card.

Bridge Balance Indicator

New "Model 203-A" is a sensitive null indicator for d-c. bridges. It converts bridge unbalance into an alternating voltage which is displayed on a 5-in. CRO. It is housed behind a panel for standard 19-in. rack. Controls are available on front panel, including an



output jack for measurement of actual unbalance voltage observed. A 50-microvolt d-c. signal will produce a 4 in. deflection. Gain is variable in decimal steps. Input resistance is greater than 2 megohms. Internal noise is less than 5 microvolts. Cathode ray tube presentation reverses in phase with change in polarity of input d.c. It is insensitive to power line pick-up in circuit under test. Operation is from 115 v. 60 cps. line.—*Industrial Control Co., 1462 Undercliff Ave., New York 52, N. Y.*

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With ordinary meters, high differential pressures present serious difficulties—but not with the Hagan Ring Balance Meter.

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For full information on Hagan Ring Balance Meters, fill in the coupon below or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

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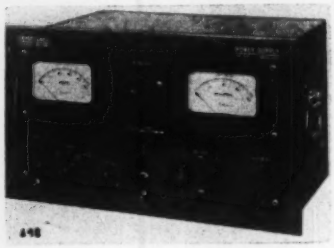
AMPEX ELECTRIC CORP.
San Carlos, Calif.

Voltage-regulated Power Supply

New "Model 515" features one regulated B supply, one regulated C supply and one unregulated filament supply. B supply is continuously variable from 0 to 500 v. and delivers from 0 to 200 ma. From 20 to 500 v. output voltage variation is less than 0.5 percent for line fluctuations from 105 to 125 volts and load variations from minimum to



maximum current. Ripple is less than 5 mv. C supply is continuously variable from 0 to 150 v. and delivers 5 ma. For all output voltages, voltage variation is less than 10 mv. for line fluctuations of 105 to 125 volts. At 150 v. regulation is less than 0.5 percent between 0 and 5 ma. At settings below 150 volts internal resistance of supply increases to a maximum of 25,000 ohms. Ripple is less than 5 mv. A-c. output is 6.3 v., 10 amps., center-tapped, unregulated. Over-all dimensions 19 x 10.5, x 13 in.—*Kepco Laboratories, Inc.*, 149-14 41*st Ave., Flushing, N. Y.*

Mention No. 1240 when filling out card.

Basic Unit Scalers

New line of basic unit scalers measure 1.75 x 10.5 in.; weigh 1 lb. Units use 5823 relay tubes; resolution time between input pulses is 1 millisecond. Higher pulse rates can be counted by preceding these units with a hard-tube scaler. Scalers operate on 180 v., have low power inputs.—*Condor Radio*, 6501 *W. 83rd St., Los Angeles* 45, *Calif.*

Mention No. 1241 when filling out card.

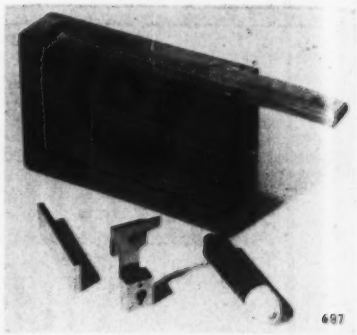
Radioactivity Indicator

New "Universal Roentgen Meter," for use with various types of tubes or chambers, is equipped with four, five or six scales, which make possible fine readings in all ranges of radiation. Four-scale model covers zero to half a milliroentgen; 0-5 mr.; 0-50 mr. and 0-500 mr. Selector switch determines which of scale will operate and will be visible, thus eliminating reading wrong scale. Instrument is sensitive enough for use in x-ray work, but also measures large amounts of radiation encountered in nuclear fission research.—*Westinghouse Electric Corp., Box* 2099, *Pittsburgh* 30, *Penna.*

Mention No. 1242 when filling out card.

Orifice Edge Gage

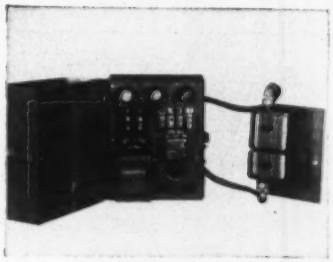
New "No. 315-050-010" orifice edge gage is based on a design suggestion by Howard S. Bean of Bureau of Standards. Gage is a precision square used to check sharp edge of metering orifices, and flatness of orifice plates. Light shining under instrument indicates squareness of edge.—*Lovins Engineering Co.*, 8203 *Cedar St., Silver Spring, Md.*



Mention No. 1243 when filling out card.

Register Regulator

New "Type RR-11" register regulator for high-speed wrapping machines permits a reduction in size of register marks on any generally-used wrapping materials such as metal foil, waxed paper, cellophane and cloth. Prefocused

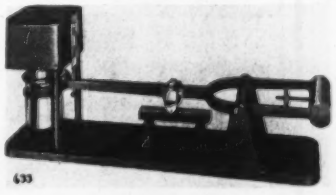


optical system requires no critical adjustments. Unit is accurate to 0.06 inch with line voltage variations as great as plus-or-minus 10 percent from normal. Toggle switch permits changing from reflected to transmitted light, and for dark- or light-spot operation. Preamplifier in scanner permits greater separation of scanner and control unit, minimizing effects of stray pickup and electrical leakage. Standard vacuum tubes can be obtained readily for normal replacements.—*Westinghouse Electric Corp., Box* 2099, *Pittsburgh* 30, *Penna.*

Mention No. 1244 when filling out card.

Transverse Core Tester

New transverse core tester consists of a cast-aluminum beam mounted on ball bearings. Loads are applied by dropping lead shot into a container at

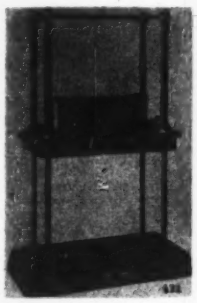


end of beam. When specimen fails, supply of shot is automatically stopped. Maximum capacity of tester is 75 lbs. on specimen. Over-all dimensions 8x36 x15 in.—*Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.*

Mention No. 1245 when filling out card.

Transverse Test Core Maker

New transverse test core maker is used in preparing samples for standard core-sand tests. Specimens 1x1x8 in. are prepared by jolting sand mixture



into a core box, from a hopper having a height of 3 in. Over-all dimensions 10x20x32 in.—*Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.*

Mention No. 1246 when filling out card.

Testing-machine Jaws

New line of tensile testing-machine jaws uses nylon members to maintain uniform pressure on sample. Both faces are self-aligning, with hardened pivot

pins. Frames are made of aluminum or steel alloys; have stainless steel threaded inserts. Jaws are statically balanced. Load capacity ranges from 50 grams to 1000 lbs. in different models.—*Instron Engineering Corp., 2 Hancock St., Quincy 71, Mass.*

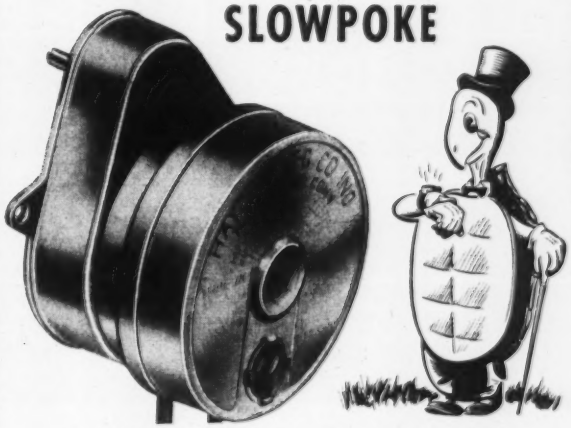
Mention No. 1247 when filling out card.

Fluorescence Detector

New "Fluoretor" is designed for daylight ultraviolet detection at either 2537 or 3660 Angstrom units, in either a portable unit operating from two flashlight batteries, or a model operating from 115 v., 60 cps. power lines. Units are supplied with integral dark chamber including three-power magnifier and six alternate specimen holders in a box. Either can be used with dark chamber removed as a black-light flashlight. Heads are interchangeable and can be obtained separately. Cold-cath-

Timing Ideas

HERE'S A COMPACT SLOWPOKE



Designers and manufacturers concerned with the excessive space requirements and high cost of external reduction gearing will welcome this new slow speed timing motor. The series 4400 requires minimum space and provides, at comparatively low costs, speeds from 6 hours to 7 days per revolution. The careful design, expert engineering and precision manufacture, are advantages common to all Haydon motors.

SUPERIORITY FEATURES

DEPENDABILITY: Slow 450 rpm rotor speed means less reduction gearing and fewer fast wheels, providing quieter operation and longer life.

SMALL SIZE: Smallest available of this type.

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- ★ Simple Pipe Flange Vac-System Connection

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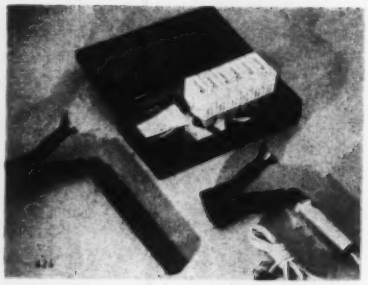
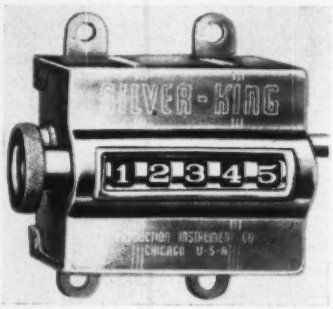


ode low-pressure discharge tubes used have no ballasts, starters nor filaments. A rubber end piece excludes light from sections of large surfaces to be examined. Battery model weighs 2 lb., 115 v. model, 1.5 lb.—*Menlo Research Laboratory, P. O. Box 522-FR, Menlo Park, Calif.*

Mention No. 1248 when filling out card.

High-speed Revolution Counter

New "Silver King" counter makes up to 4000 counts per minute. Standard models add one count for each forward shaft revolution, and subtract reverse revolutions. Modifications in-

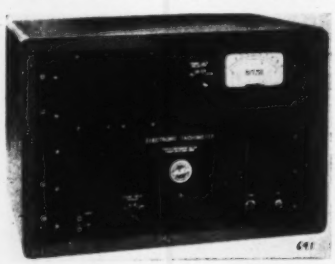


clude 5 or 7 number wheels; reset knob; right, left, or double shaft extensions. Over-all dimensions 5x4x 2.375 in.—*Production Instrument Co., 702 W. Jackson Blvd., Chicago 6, Ill.*

Mention No. 1249 when filling out card.

Electronic Counter-type Tachometer

New high-speed electronic counter tachometer, for high-accuracy revolution and frequency measurements, totalizes number of counts derived from source being measured during a precisely-established time interval of 0.6 second (0.01 minute). This reading

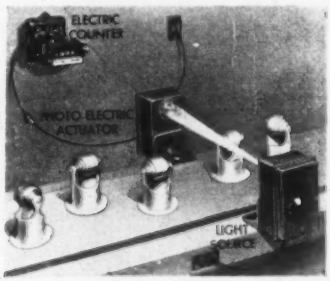


is displayed on a direct-reading, digit electronic counter using ten glow lamps for each digit. After measurement and display period instrument automatically resets and recycles. Display time is adjustable over a period of 0.5 second to 4 seconds, or can be set to hold indefinitely. Time interval of 0.6 sec. is established by counting 60,000 cycles of 100-kc. crystal oscillator contained in unit. Instrument measures frequencies up to 100,000 cycles per second with accuracy of 1 cycle. It also includes a count-rate meter which can be used when unknown frequency source is being adjusted.—*Potter Instrument Co., Inc., 115 Cutter Mill Road, Great Neck, N. Y.*

Mention No. 1250 when filling out card.

"Plug-in" Photoelectric Counting Unit

New "Counting Eye" unit includes light source, photocell actuator, and electric counter. Actuator and light



source are fully enclosed in cases 5x3.75x2.5 in., with cords for plug-in connection to 115 or 230 v., 60 cps power supply.—*Autotron Co., Box 722-Q, Danville, Ill.*

Mention No. 1251 when filling out card.

Explosion-resistant Pressure Switches

New "Bondee" pressure switch has an adjustable range from 0 to 3000 psi, with factory-set differential; is avail-

able in aluminum, brass, or stainless steel. S-p.d-t. switch is rated 15 amps. 125 v. a.c., non-inductive.—*Alloy Bellows Engineering Co., 935 Greyton Rd., Cleveland 12, Ohio.*

Mention No. 1252 when filling out card.

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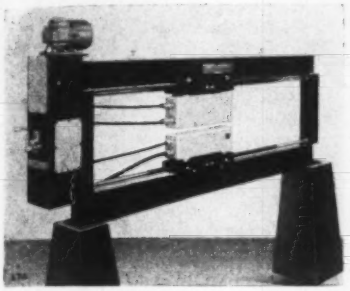
Traverse Mounting for Beta-ray Thickness Gage

New traverse mounting available for maker's "Beta Ray Continuous Mill Gage", permits gaging full width of continuous strip material. Rate of scanning is from 18 to 30 in. per minute and operation is completely automatic. Limit stops set on rail of traverse mounting automatically reverse gaging heads and scan in opposite direction. —*Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford* 1, *Conn.*



Mention No. 1253 when filling out card.

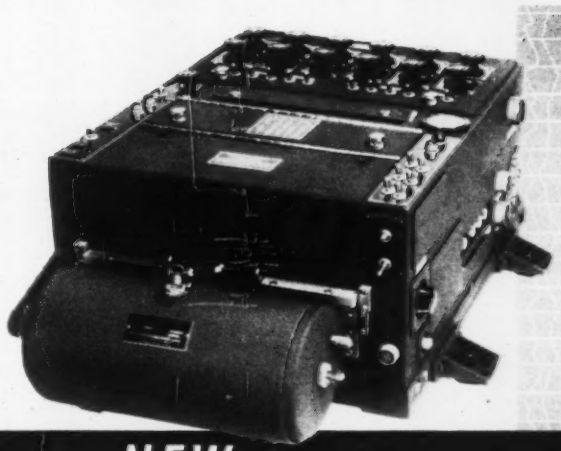
Automatic Inspector for Eccentric Shafts

New "Electrolimit" gage inspects diameters, bearing concentricity, bearing taper, and throw of eccentric in a single operation. To check a shaft, operator places it in a cradle and presses a button. Part is conveyed to gaging position where it is rotated by electric motor between "Electrolimit" contact fingers. This actuates dials, which are calibrated in hundred-thousandths of an inch. Limit hands show whether parts are within tolerance.—*Pratt and Whitney Div., Niles-Bement-Pond Co., West Hartford* 1, *Conn.*

Mention No. 1254 when filling out card.

X-ray Gaging Systems

New "Measuray" systems are improved models of maker's x-ray gages for non-contact thickness measuring of strip and sheet material. Several models are available for plastics, foil, tin plate, strip steel, etc., in thicknesses from 0.0005 to 0.420 in. Features of new models include dials for change-over of thickness setting, small scanning unit containing x-ray tube mounted inside its own transformer, elimina-



the *NEW* S-8 Oscillograph

Here, in a versatile instrument of advanced design, are all the things you need for complete oscillographic recording. The Hathaway Type S-8 Oscillograph, which has long been the standard of oscillographic recording, has been improved to meet the rapidly expanding demands of modern research. Whether your measurement problems are simple or complex, the NEW Type S-8 Oscillograph has the inherent capabilities necessary to measure vibration, pressure, acceleration, and strain with new ease and accuracy.

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QUICK-CHANGE TRANSMISSION *fully enclosed with gears running in oil* **to provide instantaneous selection of 16 record speeds over the range of 120:1**

CHART TRAVEL INDICATOR provides continuous indication of chart motion. Operator knows instantly by flashing lamp if anything should happen to interfere with chart motion

FULL-RESILIENT MOUNTING FOR MOTOR AND TRANSMISSION isolates all possible vibration and makes possible the use of modern super-sensitive galvanometers

NEW GALVANOMETER STAGE accommodates *all* Hathaway galvanometer for recording milliamperes, microamperes, or watts

NEW RECORD-LENGTH CONTROL AND NUMBERING SYSTEM designed for long, trouble-free service under all kinds of ambient conditions

All the other valuable features are retained, such as

PRECISION TUNING-FORK-CONTROLLED TIMING SYSTEM produces either 1/10-second or 1/100-second time lines across sheet

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DAYLIGHT LOADING AND UNLOADING RECORDS TO 200 FT. IN LENGTH, width to 10 inches

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AUTOMATIC BRILLIANCY CONTROL

12 TO 92 ELEMENTS

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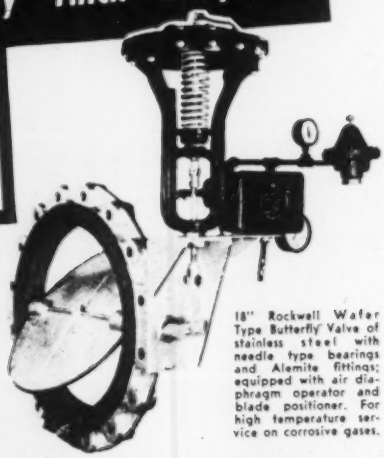
Rockwell Butterfly and Slide Valves in sizes from 1" to 72" and larger, with manual or various automatic controls, are easy to install, convenient to operate. They provide maximum flow rate and quick opening or shut-off. They pay their way in better fluid handling. We invite your inquiries. Write for the Rockwell valve catalog.



18" Rockwell Wafer Type Butterfly Valve of stainless steel with needle type bearings and Alemite fittings; equipped with air diaphragm operator and blade positioner. For high temperature service on corrosive gases.

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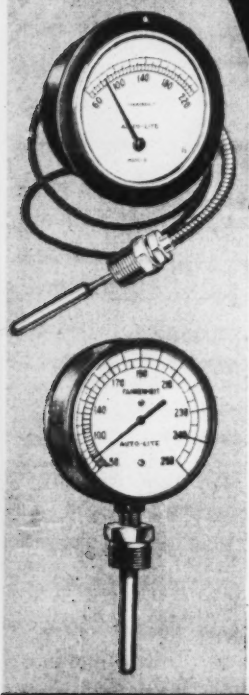

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Auto-Lite Thermometers are designed to give you the broadest selection for your needs: Priced low and precision-made for accuracy, these instruments point the way to temperature savings and help to prevent spoilage. Write for catalog showing the many styles and types of Auto-Lite Thermometers that are available.

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Illustrated, at top: Model G Indicating Thermometer, flush mounting type with capillary tubing for remote reading. Priced from $18. At bottom: Model V Thermometer (vapor pressure type). Rigid stem for direct mounting. Priced from $10.25.

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INSTRUMENT AND GAUGE DIVISION, DEPT. X-7
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INDICATING & RECORDING THERMOMETERS

tion of exterior high-voltage cables and remote control station containing all operating and calibrating controls. —*The Sheffield Corp., Dayton* 1, *Ohio.*

Mention No. 1255 when filling out card.

Surface Finish Comparator

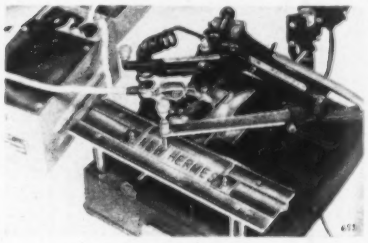
New "Precisionaire" surface finish comparator is used on flat or curved surfaces having a diameter greater than 3.75 in., where the surface roughness ranges from 30 to 500 microinches rms. Instrument does not give a direct

microinch rms. reading, but shows a reading which is a measurement of air escapement over a circle 0.125 in. diameter. Instrument is supplied with right-hand scale, 20 to 110 microinches; left-hand scale, graduations in black, 100 to 300 microinches, graduations in red, 300 to 500 microinches. Unit operates from plant air supply line.—*The Sheffield Corp., Dayton* 1, *Ohio.*

Mention No. 1256 when filling out card.

Tracer-guided Etching Equipment

New "Engravograph" uses an electric marking method for engraving on metal surfaces. Depth of etching is



controlled by an adjustable heat regulator. Machine can be converted to pantograph engraving for plastics.—*New Hermes, Inc.,* 13-19 *University Place, New York* 3, *N. Y.*

Mention No. 1257 when filling out card.

Magnetized Machinists' Level

New "Magno Level" has aluminum alloy body, with Alnico magnets for adhesion to steel surfaces. Level is indicated by enclosed gage graduated

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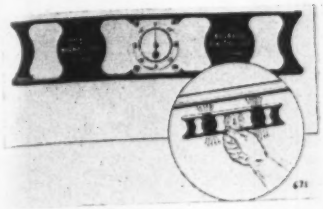
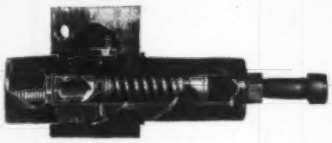


in degrees. Suitable for use in welding, pipe-fitting, maintenance, etc.—*Buckeye Plastic Corp.*, 1839 *Farmington Rd., East Cleveland, Ohio.*

Mention No. 1258 when filling out card.

Adjustable Flow Regulators

New "Model 320" flow regulator for cylinder speed control gives a constant rate of flow at any setting within adjustable range; range is 50 percent of



calibrated flow rate in gpm. It is available for hydraulic systems with operating pressures to 3000 psi. Line sizes are 0.25 to 0.75 in. NPT; maximum controlled flow is 16 gpm.—*Waterman Engineering Co.*, 721 *Custer Ave., Evanston, Ill.*

Mention No. 1259 when filling out card.

Hand Tachometers

New "Types DO and AO" are improved models of maker's centrifugal tachometers with a friction coupling which reduces damage due to occasional

or unintentional excessive acceleration and overspeeding. Instruments are available in one, three and five ranges, for speed measurement from 25 to 48,000 rpm.—*James G. Biddle Co.*, 1316 *Arch St., Philadelphia 7, Penna.*

Mention No. 1260 when filling out card.

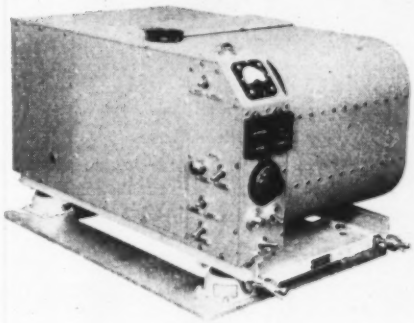
Fractional-hp. Dynamometer

New dynamometer is a self-contained unit with extended base for mounting of equipment under test. Control panel contains instruments for reading field voltage and armature current, a field control rheostat and a three-way switch for selecting resistance loads. Unit has a continuous absorption or motoring rating of 0.75 hp. at 2000 rpm.; maximum speed is 4000 rpm. Included is a

Century INDUSTRIAL

RECORDING OSCILLOGRAPH

FOR VIBRATION, TEMPERATURE, STRESS, STRAIN ANALYSIS



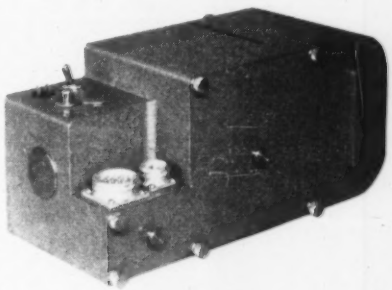
MODEL 408 OSCILLOGRAPH

The Century Model 408 recording oscillograph was designed expressly for airborne and mobile operation. As with all Century products, this oscillograph incorporates the utmost in design and workmanship, along with improved features, yet it remains simple in its operation and maintenance.

FEATURES:

- Size: 29" long, 12½" wide, 8⅞" high.
- Weight: 51 pounds.
- Number of Recording Channels: 6 to 50.
- Detachable daylight loading magazine accommodating a roll of paper or film 8" x 200'.
- Friction roller type paper drive by governor controlled electric motor with separate motor for takeup drive.
- Paper speeds continuously and instantly variable without changing gears or sprockets.
- Separate optical system for viewing before or during recording.
- Glow tube timing system photographing .01 second and .1 second lines. .01 second lines instantly removable by toggle switch for slower speeds.
- Data numbering at beginning of record.
- Footage indicator showing amount of paper remaining in magazine.
- Automatic record length control.
- Trace identification.
- Remote control unit.

MODEL 409 OSCILLOGRAPH



The Century Model 409 oscillograph has been designed for recording data where space and weight requirements are limited. This oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:

- Size: 5" x 5" x 11".
- Weight: 11 pounds.
- Cast Aluminum case.
- Paper speeds variable ½" to 12" per second.
- Detachable daylight loading magazine with a capacity of 3⅝" x 50' paper or film.
- 2 to 12 individual channels.
- Trace identification.
- Trace viewing.

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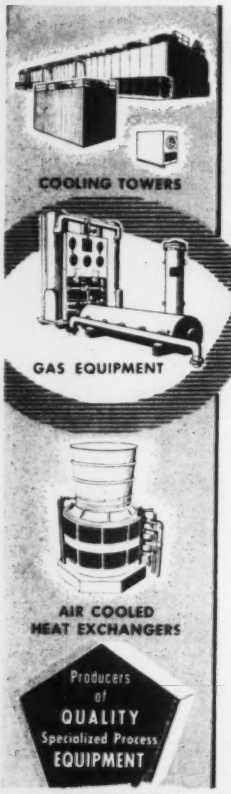

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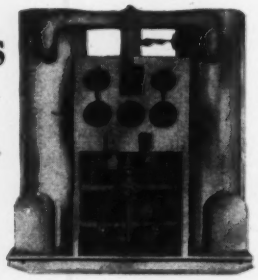

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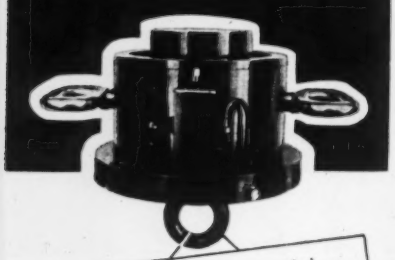

for use in applications such as dynamometers, industrial weighing, strength of structures, jet engine thrust, and countless other force-measuring problems. Illustrated is the famous Emery Hydraulic Cell, basic unit of Emery hydraulic testing and force-measuring systems.

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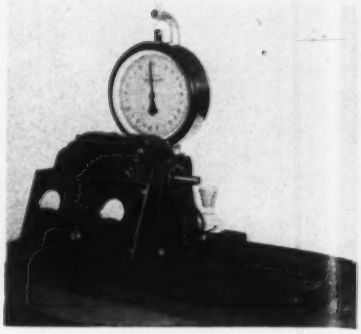
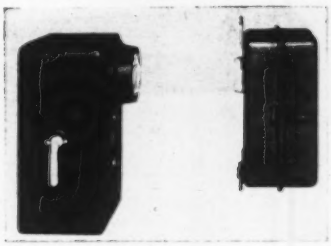


10-in. diameter dynamometer scale graduated in lbs. with 0.1 lb. subdivisions. Scale is pre-loaded to allow torque reading in either direction of rotation.—*Special Products Div., General Electric Co., Schenectady 5, N. Y.*

Mention No. 1261 when filling out card.

Photoelectric Smoke Detector

New "Type A28E" smoke detector has an operating range of 5 to 30 ft. S-p.d-t. relay is rated at 3 amp. 115



v. or 1.5 amp. 230 v. non-inductive. Relay operates at low smoke concentrations.—*Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.*

Mention No. 1262 when filling out card.

Soldering Gun

New "Model WD-135" soldering gun features dual spotlights, and over

under terminals. Unit has two heats, 5-second heating time, and chisel-shaped tip.—*Weller Electric Corp., Easton, Pa.*

Mention No. 1263 when filling out card.

Gearmotor

New right angle gearmotor is available up to 5 h.p., with ratios from 5.8:1 to 100:1. Output speeds range

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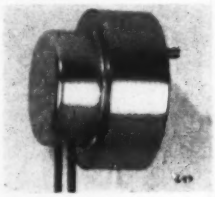
from 17.5 to 302 rpm.—*Abart Gear and Machine Co., 4828-36 W. 16th St., Chicago 50, Ill.*

Mention No. 1264 when filling out card.

Timing Motors

New "Series 400" synchonous motor is round and fits into a 2 in. circle mounting. It is available in many speeds and several types of output

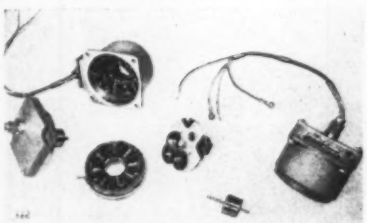


shafts. Gear train and rotor section is separate from coil and stator assembly. Input is 4 watts.—*The Bristol Motor Co., Bristol Bldg., Old Saybrook, Conn.*

Mention No. 1265 when filling out card.

Special Electric Motors for Instrumentation Purposes

New two-phase, reversible, 60 cps. motors have low inertia rotors, with free speed of 1620 rpm., geared to 27, 54, or 162 rpm. output, as specified.



Line field winding draws 9.5 watts, control field draws 4 watts. A d-c. component in control field acts as a braking current when a-c. excitation stops.—*Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Wayne and Roberts Ave., Philadelphia 44, Penna.*

Mention No. 1266 when filling out card.

Check Valves

New "Circle Seal" check valves, available in sizes from 0.125 to 1 in., are poppet type, with synthetic ring seals. Body is available in a variety

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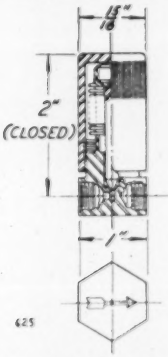
of metals, with ratings to 3000 psi., 500 F. Standard range of opening pressure differentials is 4 in. water to 5 psi. Poppet closes before start of return flow.—*James-Pond-Clark, Pasadena, Calif.*

Mention No. 1267 when filling out card.

Packless Needle Valve

New "No. 314" packless needle valve has 0.063 in. ports, with body tapped for 0.125 in. NPT. All parts are made of 347 stainless steel. Bellows ends

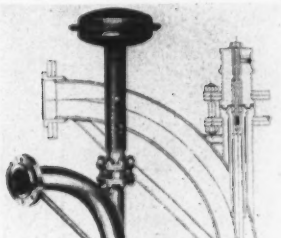


are resistance welded to heads. Valve operates by turning knurled cap. Body is rated to 150 psi., 375 F.—*Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Knoxville 4, Tenn.*

Mention No. 1268 when filling out card.

Long Sweep D-m. Angle Valve

New "7000S Series" angle valve body is a long radius bend, available in any alloy which can be bent and welded. Streamlined valve plugs have lifts half



nominal valve size. Retained seat is a section of Venturi throat. Through-bolted bonnets are machined from bar-stock; "Oilite" bearings on stem permit vertical or horizontal mounting. Standard spring range is 3-15 psi.; body sizes 2 to 6 in.—*Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.*

Mention No. 1269 when filling out card.

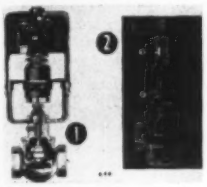
Electrohydraulic Motor Valve

New "Type O Sarcostat" valve is designed for two-wire, 110-v. 60-cps. operation. Electric-motor-operated oil pump opens valve in 60 sec. when external control contact closes. Needle, or single- or double-seat, valves are available in brass or iron bodies. Explosion-proof operator housing can be supplied.—*Sarco Co., Inc., Dep't. 115, Empire State Bldg., New York 1, N. Y.*

Mention No. 1270 when filling out card.

Diaphragm-motor Valve

New "Metaflow" valve is diaphragm operated for pressure differentials below 75 psi. Housing is aluminum alloy, with brass bellows motor. Adjusting screw is brass, with rust-proofed steel

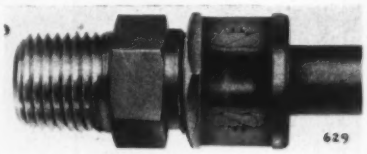


spring having 15 psi. adjustment range. Bonnet has polished stainless steel stem in preformed metallic packing. Body is bronze, rated 125 psi.; screwed ends from 0.5 to 2 in. Composition disk with integral seat. Packless body is also available.—*Powers Regulator Co., 2734A Greenview Ave., Chicago 14, Ill.*

Mention No. 1271 when filling out card.

Instrument-tubing Fittings

New "Swagelok" fittings are available in several metals, for tubing from 0.125 to 1 in. o.d. Two ferrules and

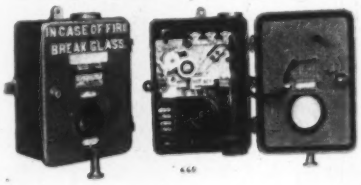


threaded chuck inside nut clinch tight around tubing when nut is tightened one and one-quarter turns.—*Crawford Fitting Co., Cleveland, Ohio.*

Mention No. 1272 when filling out card.

Combination Operation Fire-alarm Box

New "MA-ET" fire alarm box may be automatically actuated by rate-of-rise or fixed-temperature thermostats, or manually tripped by breaking glass.



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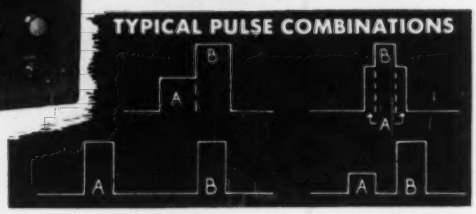

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PULSE DURATION individually adjustable from 0.15 to 1.5 microseconds; **RISE TIME** is .05. **DECAY TIME** 0.10 microseconds. **SPACING** between pulses variable from −0.5 to +10 microseconds. **REPITITION RATE** adjustable in 3 ranges, 1 to 10, 10 to 100 and 100 to 1000 cycles; can be externally triggered. **OUTPUT IMPEDANCE** approximately 400 ohms, maximum output voltage, −200 v. **CONTROL CALIBRATION ACCURACY** ±5% over entire range.

The Berkeley Double Pulse Generator produces two pulses individually controllable in width, amplitude and time relation to each other. Pulse amplitude is individually adjustable without cross effect from 0 to +50 v. and 0 to −200 v. A fine control, plus a 10 to 1 step attenuator permits varying the amplitude of both pulses after mixing.

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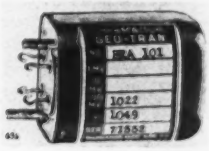
When box is tripped, either automatically or manually, four complete rounds of coded alarm are transmitted, and a "NOT SET" target drops into view. Facilities for testing movement and signals are provided.—*The Autocall Co., Shelby, Ohio.*

Mention No. 1273 when filling out card.

Transformers and Chokes

New "Thermador Type HR" transformers and chokes are hermetically sealed in metal cases for shielding against stray fields. Units are matched

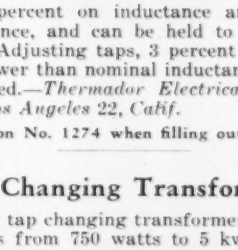


to 5 percent on inductance and a-c resistance, and can be held to 1 percent. Adjusting taps, 3 percent higher and lower than nominal inductance, are provided.—*Thermador Electrical Mfg. Co., Los Angeles* 22, *Calif.*

Mention No. 1274 when filling out card.

Tap Changing Transformers

New tap changing transformers have ratings from 750 watts to 5 kw. Primary windings are for either 115 or



230 v., with secondary voltage adjustable in 36 steps in all but 5 kw. model, which has 72 steps.—*Hevi Duty Electric Co., Milwaukee* 1, *Wis.*

Mention No. 1275 when filling out card.

Ultra-low-frequency Band-pass Filter

New "Model 330-A" ultra-low frequency band-pass filter has adjustment for high and low cut-off frequencies from 0.02 to 2,000 cps. Gain is unity in pass band and drops to 24 db/octave outside. Attenuation at corner frequencies is small but no peaks greater than 1 db in gain vs. frequency plot are produced. A band width of one octave

may be used. Features include low internal noise, input and output buffer stages, and electronic regulated power supplies.—*Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.*

Mention No. 1276 when filling out card.

Antivibration Relays

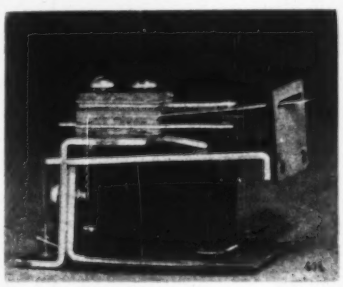
New "Series M" relays measure less than 0.625 x 0.75 x 2.06 in. and weigh less than 0.5 oz. Unit is claimed to withstand 20g vibration and more than 50g acceleration in any direction, without affecting contact position. Coil is

universal-wound and vacuum impregnated. Solder lugs are widely spaced. Mounting is accomplished with one screw and an extruded locating pin. Coils are available in ratings from 1 to 72 v., d.c., with resistances ranging from below 1 ohm to 5000 ohms. Contacts are coin silver, 0.063 in. diameter, and rated 1 amp. Illustrated is Model 5500 s-p.d-t. relay rated at 5000 ohms, 72 v., d.c.—*Neomatic, Inc., 879 Wellesley Ave., Los Angeles 49, Calif.*

Mention No. 1277 when filling out card.

High-differential A-c. Relay

New "Series 1816" relay has a 15,000-ohm coil; operates on 5 ma. d.c. Contacts are snap action, rated 15 amp., 115 v., or 7.5 amp., 230 v., a.c. Relay



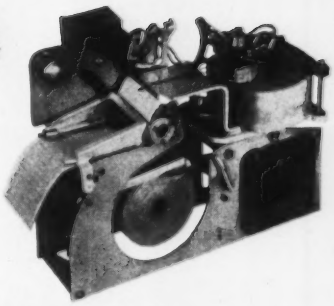
is designed for high differential between pull-in and drop-out. Normal high-speed action may be slowed by capacitors across coil. Contacts are s-p.d-t. or d-p.d-t. Coil is impregnated against moisture. Over-all dimensions 1.25 x 2.5 x 1.75 in. Weight is 5 oz.—*Assembly Products, Inc., Chagrin Falls, Ohio.*

Mention No. 1278 when filling out card.

Combination Sensitive and Power Relay

New two-stage sensitive contactor with three-position center-stable armature suspension is used as output device for servo amplifiers. When ad-

DIRECT WRITING **RECORDERS**

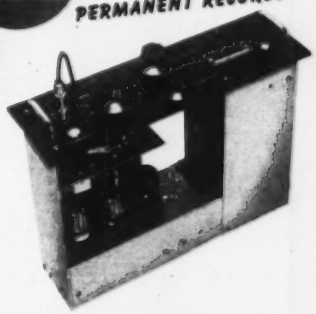


Records are produced by a heated writing stylus in contact with heat sensitive paper. The paper is pulled over a sharp edge in the paper drive mechanism (standard speed 25 mm/sec., slower available) and the stylus wipes along this edge as it swings, thus producing records in *true rectangular coordinates.* The writing arm is driven by a D'Arsonval moving coil Galvanometer with an extremely high torque movement (200,000 dyne cms per cm deflection).

This recorder assembly may be obtained in bare chassis form, as illustrated (51-600) with or without built-in timer; or, with the addition of a stylus heating transformer, temperature controls, and control panel (127); or, with the entire assembly, controls and control panel enclosed in a mahogany carrying case (127C). Complete catalog available, see below.

SINGLE CHANNEL — NO INK — RECTANGULAR COORDINATES — PERMANENT RECORDS

INSTRUMENT AMPLIFIERS



A general purpose, A.C. operated driver amplifier for use with model 127 Recorder, comprising three direct coupled push-pull stages. Maximum sensitivity 50 mv. per cm., minimum sensitivity 50 volts per cm., with four intermediate ranges. Balanced input terminals available with impedances of 5 megohms to ground. Complete information in catalog shown below.

AMPLIFIER-RECORDERS

Model shown at right is a single channel unit comprising above Amplifier 126 and Recorder 127, contained in one mahogany carrying case, and designed for use in the industrial field as a direct writing vacuum tube recording voltmeter capable of reproducing any electrical phenomena from the order of a few millivolts to more than 200 volts. More complete data in catalog shown below.

At lower right is a typical "Poly-Viso" multiple channel direct writing Recorder and Amplifier in console. Numerous combinations of this recording equipment and associated amplifiers and accessories are available. The Multi-channel Recorder (Model 165) provides for the simultaneous registration of *up to four* input phenomena, using the same principles and method as for the Recorder Assembly above. In addition, the "Poly-Viso" Recorder provides a selection of eight paper speeds: 50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec., and for the use of 4, 2, or 1 channel recording Permapaper. The Amplifier equipment is housed in a rack which has space for four individual driver amplifiers (electrically identical to model 126, above) and one 4-channel preamplifier.

NO INK — MULTI-CHANNEL — RECTANGULAR COORDINATES — PERMANENT RECORDS

For complete catalog giving tables of constants, sizes and weights, illustrations, general description, and prices, address:

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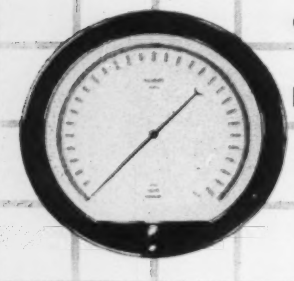
Sanborn Recorders and Amplifiers have evolved from those originally designed by Sanborn Company for use in electrocardiographs, and have, by actual practice, proven to have wide applications in the industrial field as well.



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Heise Bourdon Tube Company, Inc.
Newtown, Connecticut

justed for full-stroke armature motion, relay latches after momentary operation. Adjusted at high sensitivity, with two-position spring-biased armature, it can be controlled by a low-power plate circuit, and switch several power circuits directly.—*Sigma Instruments, Inc., 70 Ceylon St., Boston, Mass.*

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Ultra-low Frequency Rejection Filter

New "Model 350-A" provides either a rejection band in which gain falls at 24 db per octave or a sharp single frequency null. For either case, gain is unity outside rejection region. High and low cut-off frequencies of rejection band are independently and continuously adjustable from 0.02 to 2000 cps. A sharp null may be obtained at any frequency between 0.1 and 500 cps. Gain is within 3 db of unity at one octave above or below null frequency. Features include low internal noise, single-scale logarithmic dials, regulated power supplies, and input and output buffer stages.—*Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.*

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Radio-noise-suppressor Capacitors

New "Type 1N Series" . . . been designed for automotive applications; capacitor elements are rigidly clamped to withstand shock and vibration. Flexible wire leads are weather-proof with high temperature plastic insulation. Capacitor element is non-inductive, vacuum wax-impregnated, in a hermetically sealed case. Units are available in three mountings and at 0.25 and 0.5 uf. 150 v.d.c.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

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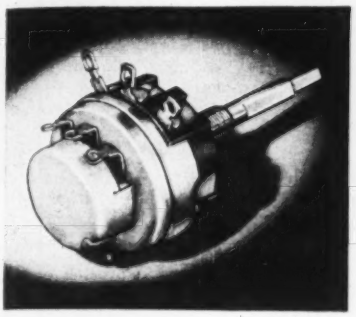

rear element is carbon resistor. Concentric shafts allow independent control in either circuit.—*Clavostat Mfg. Co., Dover, N. H.*

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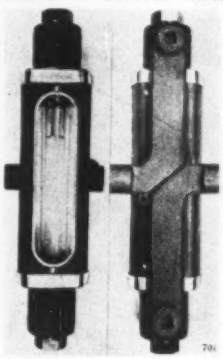
Rotameter Adapter for Horizontal Lines

New adapter, for installing maker's "Flowrator" meters in horizontal piping, is made in several metals and

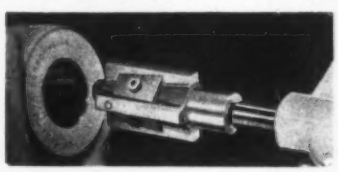


may be used with all standard meters. —*Fischer & Porter Co., 25 County Line Road, Hatboro, Penna.*

Mention No. 1283 when filling out card.

Adjustable Gaging Spindles

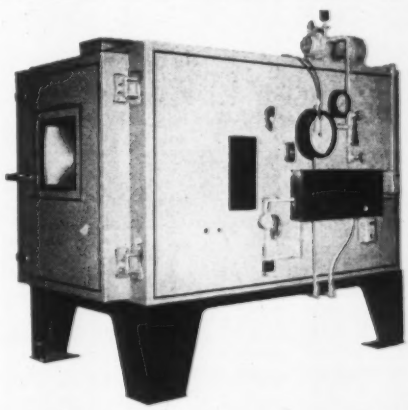
New adjustable gaging spindles are of ball-jet contact type; are available in either through-hole or blind-hole styles. Unit consists of tapered core and four clamps to hold blades in place, together with set of four blades, two of which have inserted ball-jets. Full range of 1 to 3 in. can be covered with 4 sets of blades and 8 cores; other ranges are covered with fewer components. One minimum and one maximum setting ring are required for calibrating air gage for proper amplifi-



"LOOK, SAM, MEETING TOUGH TEST SPECS IS NO PROBLEM NOW... EVEN..."

No. 41065-B

(U.S.A.F.)



The TenneyZphere Altitude Chamber shown here was built to run environmental tests on aircraft electrical components, in accordance with 41065-B. Conditions met: Group 10 (high temp. tests), Group 20 (low temp. tests), Group 30 (humidity tests), and Group 40 (high altitude tests). Specified range from −103°F. to +200°F. Relative humidity—20% to 95%. Altitudes to 85,000 ft. Sizes from 3 cu. ft. to walk-in rooms.

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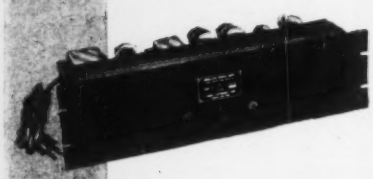

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cation. These spindles are recommended for air gages having amplifications of 2,000 to 1 or less.—*The Sheffield Corp., Dayton* 1, *Ohio.*

Mention No. 1284 when filling out card

Midget Snap-action Switch

New "Model M-OM," shown in actual size, is suitable for condensed timing and sequence operations. It is an open-blade switch utilizing maker's rolling

spring principle. Current-carrying capacity is 3 amps. at 125 volts, a.c. Rated capacity life is 500,000 actuations.—*Acro Switch Division, Acro Mfg. Co., Columbus* 16, *Ohio.*

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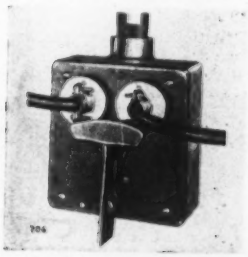
Interlock Receptacle with Breaker

New interlock receptacle incorporates a lever which makes it impossible to remove cord while current is on. Turning lever breaks circuit and allows

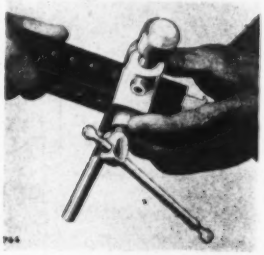


plugs to be removed. Standard single or duplex receptacles, with capacities to 20 amp. are available.—*Panellit, Inc., 7218 No. Clark St., Chicago* 26, *Ill.*

Mention No. 1286 when filling out card

Tube Flaring Tool

New "Model 410" tube flaring tool combines a flaring pin in a vise slide on a hardened split die block having a series of holes to accommodate 0.25 to 0.625 in. tubing. Flaring pin point will



handle heavy-wall tubing in 0.25 in. size, and vise screw nose has self-aligning engagement with block.—*Parker Appliance Co., 17325 Euclid Ave., Cleveland* 12, *Ohio.*

Mention No. 1287 when filling out card.

Books Received

ELECTRONICS—PRINCIPLES AND APPLICATIONS. By Ralph R. Wright. Ronald Press Co., New York, N. Y., 1950. Cloth, 6 x 9¼ inches, 387 pages, $5.50. Intended for use in a basic course in electronics for non-electrical engineering students, the book is by no means limited to that use. Various types of basic circuits illustrating the principles of electronic control circuits are explained; topics are presented from a qualitative rather than a quantitative point of view.

MEASURING OUR UNIVERSE. By Oliver Justin Lee. Roland Press Co., New York, N. Y., 1950. 6 x 8¾ inches. Cloth, 170 pages, $3.00. In this book you will find the human story of how our familiar units of length grew out of the practical experience of men for thousands of years and how the development of the sciences made it necessary to define and standardize these units and to invent new ones.

DIE FEINMECHANIK UND INDUSTRIE DER MESSINSTRUMENTE IN DER SCHWEIZ—3rd Edition, Available at Business Publications, New York, New York, 1949. Cloth, 6 x 9¼ inches, 120 pages, $3.00. A directory of the precision and measuring industry of Switzerland. Included are names of Swiss manufacturers of precision and measuring instruments, dates of establishment, capital invested, names of staff, etc.

PIEZOELECTRIC CRYSTALS AND THEIR APPLICATION TO ULTRASONICS. By Warren P. Mason. D. Van Nostrand Company, Inc., New York, N. Y., 1950. Cloth, 6¼ x 9¼ inches, 508 pages, $7.50. A comprehensive account of piezoelectric crystals, their investigation, production, and industrial applications—with particular reference to the discovery and development of the synthetic crystals DKT (dipotassium tartrate) and EDT (ethylene diamine tartrate).

THEORY AND DESIGN OF ELECTRON BEAMS. By J. R. Pierce. D. Van Nostrand Company, Inc., New York, N. Y., 1949. Cloth, 6 x 9¼ inches, 197 pages, $3.50. This book is a composite of the theoretical material necessary for a good understanding of electron flow and electron focusing in devices other than electron microscopes and image tubes. Material is presented to it can be understood without reference to other sources. No attempt is made to deal with problems of experimental technique.

ELECTRONIC ENGINEERING MASTER INDEX. Edited by John F. Rider. Electronics Research Publishing Co., Inc., New York, N. Y., 1950. Cloth, 6¾ x 9¾ inches, 339 pages, $19.50. A subject index to the contents of electronic and allied engineering publications printed throughout the world from January 1947 through December 1948.

Index of NOMOGRAMS. Compiled and edited by Douglas Payne Adams. John Wiley & Sons, Inc., New York and Technology Press, Cambridge, Mass., 1950. Cloth, 7¼ x 9¾ inches, 174 pages, $4.00. Index lists over 1700 published nomograms in well-known periodicals, and serves as an invaluable time-saver in the repeated solution of mathematical formulas. Book is divided into two main parts, Index A—Key Words, and Index B—Master Index.

INDUSTRIAL INSTRUMENTATION. By D. P. Eckman. John Wiley & Sons, Inc., New York, 1950. Cloth, 5⅝ x 5⅝ in., 396 pages, $5.00. Covers temperature, pressure, vacuum, composition, liquid level, gaging, flow and process instrumentation. Furthering the analytical (rather than empirical) approach, the author reviews such principles of mechanics, thermodynamics, and electricity as apply directly to problems of measurement. "It focuses attention," says the author, "on the fundamentals of engineering application." Fundamentals mastered, the engineer is equipped to extend measurements far beyond elementary concepts of temperature and pressure determinations.

SALES ENGINEERING. Second Edition. By Bernard Lester. John Wiley & Sons Inc., New York, 1950. Cloth, 5¾ x 8½ inches, 226 pages, $3.00. This book is concerned with "the art of selling equipment and services that require engineering skill in their selection, application and use," and describes the type of work this involves, the opportunities it offers for a career,

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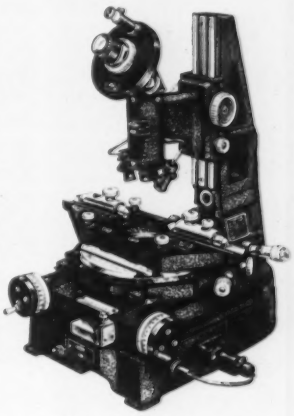

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Coordinate Measurements
Left to Right ..... 100 mm or 4 inches
Front to Rear ..... 50 mm or 2 inches

Direct Reading to ..0.002 mm or 0.0001 inch

Angular Measurements

Stage Range	360°
Reading with Vernier	1 min.
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Reading with Vernier	1 min.
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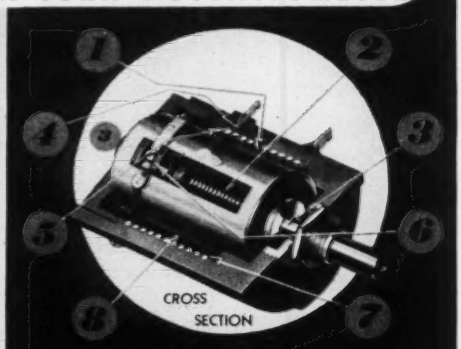

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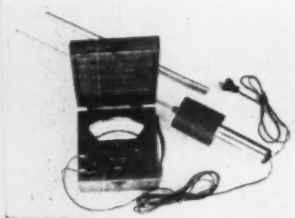

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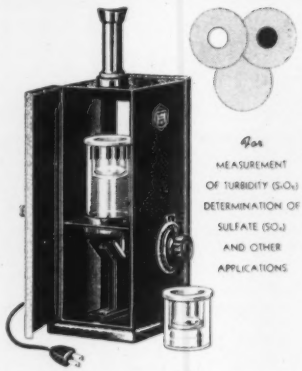

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HANDBOOK OF AERIAL MAPPING AND PHOTOGRAMMETRY. By Lyle G. Trorey. Cambridge University Press, New York, 1950. Cloth, 6¾ x 9¾ inches, 178 pages, $5.00. A manual to be of use in the making of maps from air photographs. Formulae are quoted though not necessarily proved; the book is not to serve as a text. A large number of examples have been worked out in careful detail so that the application of the formulae is made very clear.

APPLICATIONS OF INTERFEROMETRY 4th-Edition (Methuen's Monographs on Physical Subjects). By W. Ewart Williams. John Wiley & Sons, Inc., New York, 1950. Cloth, 4¼ x 6¾ inches, 104 pages, $1.25. One of a series of small monographs intended to supply readers of average scientific attainment with a compact statement of the modern position in each subject. This particular one adequately covers its subject and each chapter includes references pertinent to it.

X-RAYS. Third Edition (Methuen's Monographs on Physical Subjects). By B. L. Worsnop and F. C. Chalklin. John Wiley & Sons, Inc., New York, 1950. Cloth, 4¼ x 6¾ inches, 126 pages, $1.25. Compact, concise, up-to-date coverage of this subject by authors actively engaged in research on the subject.

THE PROPERTIES OF METALLIC MATERIALS AT LOW TEMPERATURES. by P. Litherland Teed. John Wiley & Sons, Inc., New York, 1950. Cloth, 5-½ x 8-¾ in., 222 pages, $3.50. Book begins with a review in broad outline of the subject in relation to fundamental physics. Includes experiments on low-temperature changes in properties of aluminum, ferrous alloys, magnesium alloys, steels, copper, nickel, zinc, tin, and lead.

HEAT AND TEMPERATURE MEASUREMENT. Edited by Robert L. Weber. Prentice-Hall, Inc., New York, N. Y., 1950. Cloth, 5-⅞ x 8-⅝ in., 422 pages, $6.65. This book describes methods of heat and temperature measurement and includes the theoretical principles necessary for their appreciation, intelligent use, and extension. The emphasis is on experimental methods rather than on thermodynamic theory.

PRACTICAL BENCHWORK FOR HOROLOGISTS. Revised Eighth Edition. Edited by Louis and Samuel Levin. Louis Levin & Son, Inc., Los Angeles, Calif., 1950. Cloth, 6-¼ x 9-¼ in., 381 pages. A book for the beginner and experienced watchmaker, instrument maker and machinist. The emphasis is upon good tools and how to use them. Contains 475 illustrations.

RESPONSE OF PHYSICAL SYSTEMS. Edited by John D. Trimmer. John Wiley & Sons, Inc., New York, N. Y., 1950. Cloth, 5-½ x 8-⅝ in., 268 pages, $5.00. This book on instrumentation and the measurement process shows how to use mathematical techniques on physical systems. Closely linked with cybernetics, this general study includes in its domain not only physical systems but biological and sociological entities as well.

HANDBOOK OF EXPERIMENTAL STRESS ANALYSIS. Edited by M. Hetenyi. John Wiley & Sons, Inc., New York, N. Y., 1950. Leatherette, 6 x 9-¼ in., 1077 pages, $15.00. A unified presentation of all existing experimental methods for the determination of mechanical strength. The material should be of value to technical men including machine designers, structural designers, aeronautical engineers, instrument designers, etc.

THE CONDENSED CHEMICAL DICTIONARY 4th Edition. Revised by Professor Arthur Rose. Reinhold Publishing Corp., New York, N. Y., 1950. Cloth, 6-¼ x 9-¼ in., 726 pages, $10.00. This reference book is an up-to-date dictionary of chemistry, raw materials, trade names and processes. Covers all recent developments and will be of value to everyone needing quick, accurate information on chemicals and related materials. Includes definitions of common chemical terms.

THE BUSINESS HELPER. By Leslie C. Rucker. John F. Rider, Inc., New York, 1949. 138 pages, $2.00. A nontechnical Handbook for the modern man operating a small business. Covers the highlights of organizing and operating a business.

A MEASURE OF GREATNESS. By David O. Woodbury. McGraw-Hill Book Co., Inc.

N. York, 1949. Cloth 6¼ x 9¼, 230 pages, $4.00. The biography of Edward Weston, renowned electrical inventor, gives the background of this famous pioneer in the instrument field and the founder of the Weston Electrical Instrument Co.

THE ACCELERATION OF PARTICLES TO HIGH ENERGIES. Edited by H. R. Lang. Institute of Physics, London, 1950. Cloth 6 x 10, 58 pages, $1.60. This volume contains the papers presented on the last day of 1949 Institute of Physics' Convention. Contributors include: J. Rotblat, "The Cyclotron," F. K. Goward, "Betatrons and Synchrotons," E. S. Shire, "Electrostatic Generators and Linear Accelerators," and following discussion edited by V. J. Francis.

RATING EMPLOYEE AND SUPERVISORY PERFORMANCE. American Management Association, New York, 1950. Paper 8½ x 5½, 170 pages. Review by 14 authorities on merit-rating principles and techniques in application to offices and plants of any size.

INDUSTRIAL ELECTRONIC CONTROL. 2nd Edition, by W. D. Cockrell. McGraw-Hill Book Co., Inc., New York, 1950. Cloth 5½ x 8¼, 385 pages, $4.00. This book explains the fundamentals of electron-tube operation and shows application in the basic circuits used in present-day industrial electronic control. Illustrates numerous commercial circuits and includes useful information on many circuits, such as counters, clamps, switches and gates.

TECHNICAL SOCIETIES

SOCIETY FOR APPLIED SPECTROSCOPY

The November meeting of the Society for Applied Spectroscopy will be held on Tuesday the 7th: 6:00 p.m., Informal Dinner, 'Tosca's, 118 Fulton Street, New York, No reservation necessary.

8:00 p.m., Regular meeting, Socony-Vacuum Training Center, 63 Park Row. Speaker, David Richardson, Bausch & Lomb Optical Co. Subject, Echelles vs. gratings. Technical Chairman, Robert W. Murphy, Socony-Vacuum Laboratories.

The date of the next following meeting is Dec. 5, 1950.—CHARLES H. NORTH, Publicity Chairman, Nat'l Lead Co., Titanium Div., P.O. Box 58, South Amboy, N. J.

DATE CHANGED FOR 1951 PITTSBURGH CONFERENCE ON ANALYTICAL CHEMISTRY AND APPLIED SPECTROSCOPY

The 1951 *Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy* will be held at the William Penn Hotel, Pittsburgh, Pennsylvania March 5-7 (formerly February 28-March 2).

The Conference is jointly sponsored by the Analytical Chemistry Group of the Pittsburgh Section of the American Chemical Society and the Spectroscopy Society of Pittsburgh.

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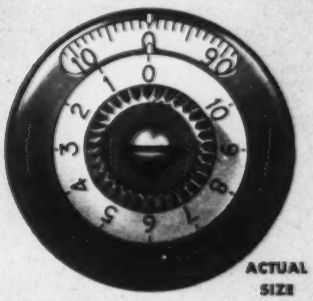
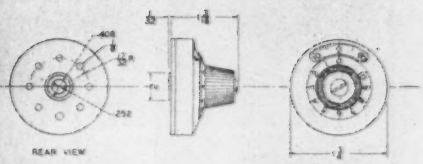


ACTUAL SIZE



REAR VIEW

Microdial . . . turn-counting dial, primarily designed for use on Micropot ten turn linear potentiometers . . . use it on any multiturn device having ten turns or less.

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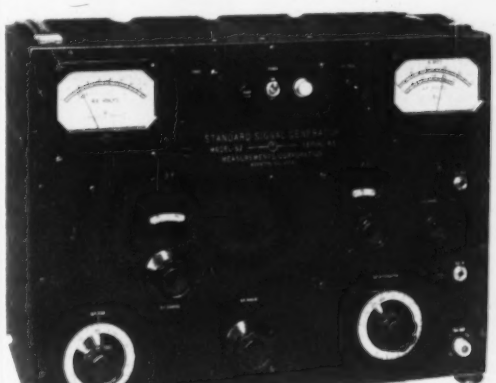

Measurements Corporation

Model 82

For audio and radio frequency measurements of AM, FM and TV receivers. For testing and checking the frequency response of audio systems; as a driving source for AF and RF bridges; for testing video and wide-band amplifiers.

- Continuous range from 20 cycles to 50 Mc.
- Individually calibrated dials.
- Low harmonic output.
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Write for Circular No. 94 for complete specifications

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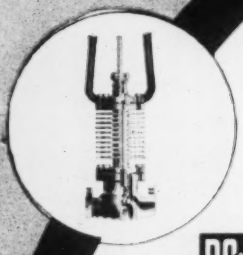
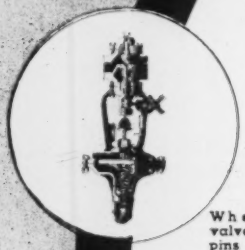
VERSATILE

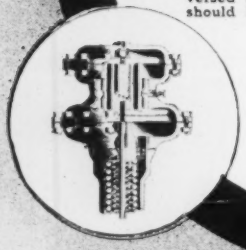
Control flow, temperature, pressure or liquid level...handle air, gas, vapor, steam or liquids equally well with the BS&B-Climax type 86! Wide rangeability and constant proportional flow increase as valve opening increases with travel is a result of high-lift design and characterized inner valves. A full line of accessories permits scores of adaptations.



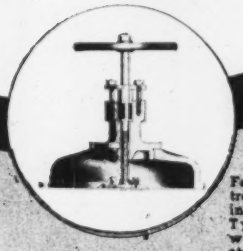
When flowing medium utilizes temperatures above 450° F., it is advisable to insert steel finned section for cooler operation.



Where needle valve or metering pins are used in valves that must be closed on failure of operating medium, Type 86 DRT with reversed top works should be used.



Where safety factors require that valve must not go out if diaphragm ruptures, employ Type 98 Duplex Diaphragm.



For manual control and for limiting valve travel, Type H Handwheels are installed on upper diaphragm casing.

BS&B

Climax DIAPHRAGM CONTROL VALVES

TYPE 86 is available in double port sizes ½ inch to 16 inches; single port, ½ inch to 4 inches. Pressure ranges are 125 to 5000 psi, within body limits. Parabolic, quick-opening, V-port, needle and metering pin inner valves are offered. Available with reverse top works, duplex diaphragm, finned cooling section, purged gland section, handwheels, bellows stem packing, steam-jacketed bodies and valve positioners.

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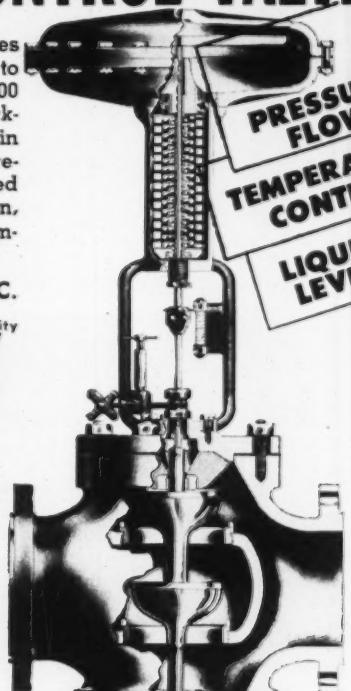

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☐ Send catalog and complete information about BS&B Climax Type 8[illegible] phragm Control Valves. ☐ Have Sales Engineer call. No obligation of course.

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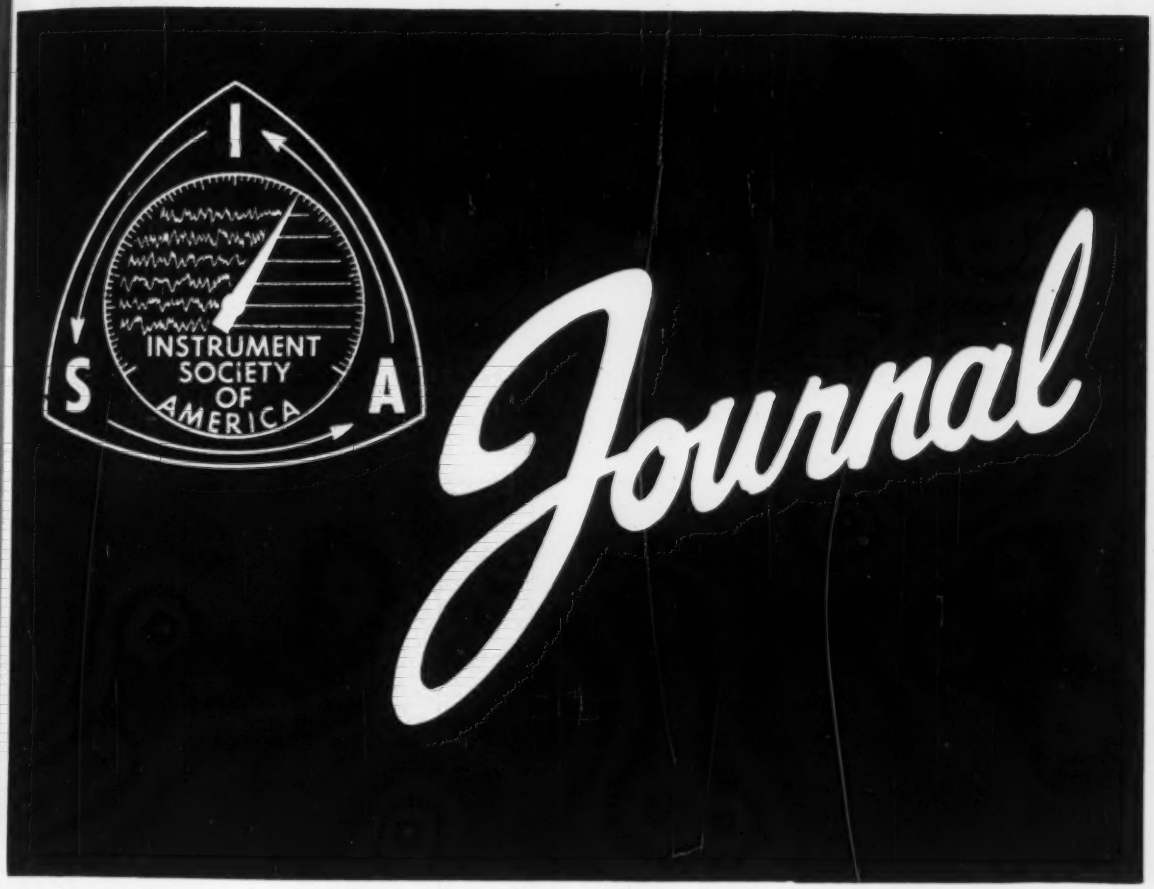

PRESIDENT'S REPORT

Year Ending September, 1950

IT GIVES me great pleasure to report to you the state of the Society during the past year. It may be said that growth continues healthy and that it seems to us who have been charged with the major portion of the operations that progress has generally been made on most of our lines of endeavor.

I might point out to you as members of a very young society that the most difficult period in any national society's history is probably the first ten years, which we have not yet completed. There are a good many reasons why this should be so, one of which is it parallels the situation in the development of any industrial device and for much the same reasons. The young society is composed of members, in general, apt to be inexperienced in how a society must operate under entirely voluntary conditions so as to produce what amounts to a successful business entity. The members are unfamiliar with the mechanisms that have been developed and accepted by the older societies and in many cases spend valuable time arguing about the right method when it is probably desirable that a young society should be willing to accept the extremely valuable guidance obtainable from the experience of older societies.

The second is the difficulty in any new venture, and that is, it is hard to get enough cash in the till. It is nearly always the case that a considerable percentage of members in a new society want to know what they are going to get out of it, and of course for the first ten years the general answer is, "How much are you going to put into it?". We have, I think it may be said, at the beginning of our fifth year of operation come over the mill dam and through the whirlpool at the foot of the dam into relatively quieter water at the bottom where the boat can travel more easily at an even keel. We have in this period expanded from 1000 members to over 4000, from less than 20 chapters to over 50; and comparison with the growth rates with other societies shows we started extremely healthily with respect to numbers and growth rate, better than many of the other older established societies. It is also true, however, that our growth during this last year is not as great as in previous years and this may be due to the uncertainty of the times which have come upon us. It would seem, therefore, that we may congratulate ourselves upon having weathered the first five years with pretty good success.

I might point out in consideration of the structure under which this Society operates that it has been found in all business that the type of structure under which an organization operates is not nearly so important as how well they operate the structure which subsists. To my mind it would make very little difference how our rules are produced or directed, as long as we operate them assiduously and conscientiously just as they stand. There were many new ideas brought forth, mostly as objections to the constitution under which we started to operate and which was admittedly imperfect, which have finally been crystallized in a definite structure, modified not too greatly from the original but felt to be more workable by the Constitution Committee who have given it careful thought for a long period of time. This Constitution has also had the consideration of our Structure and Planning Committee and is expected to be presented to the Board of Directors for vote.

One other point that needs remembering is that the ideas as to how the Society should operate differ in the various sections. It must be remembered in all chapters, that in voluntary organizations of this sort each section must be willing to sacrifice its own pet ideas and should operate under those satisfactory to the majority.

I would like to stress to you the necessity of planning far ahead in

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conferences and exhibits due to the fact that there are great difficulties in obtaining proper exhibit facilities as well as hotel accommodations in a relatively few number of cities; in some of the larger of these the accommodations are not always satisfactory, and very frequently already largely committed. It is not too much for us to lay out our plans on where exhibits and national conferences are to be held for a running period of five years continuously. I am quite sure that the majority of the membership do not realize the tremendous amount of work that must be done in order to properly schedule a conference and exhibit.

In any case the growth of the Society has naturally been followed by a growth in the activities in these two directions so that more and more work is required of the National Office. In some cases the local section where the exhibit is to be held cannot provide enough members for the committee activities in their own section and this throws still more work on the National Office. This great increase in work in the National Office indicates that we shall have to increase the staff and expenditures in order properly to cover the work now required of the staff. To illustrate what I mean, the ASME has about one staff member per 130 members; the SAE about one staff member per 200 members; we have been operating with not much better than one staff member per 1000 members—obviously much too low. Of course it is true that the two large societies mentioned above have been in existence better than 40-50 years, are 4-5 times our size, and have dues 5 times ours. It is also true that they have additional income which as yet this Society is unable to obtain—the sale of publications and advertising. These advantages, of course, we are undoubtedly likely to reach. It is my feeling that the staff at National Headquarters will have to be increased from 50 to 100 percent during the next year or so.

May I draw your attention to the fact that the increase in the tremendous work operating the conference and exhibit is due to the fact that the deadline for scheduling the papers for the conference is altogether too short and in some cases it is impossible to prepare preprints. I am quite sure that this young Society will have to learn to pay more attention to deadlines and to getting papers in on time and in considering these papers to be a serious engagement. It is true that our membership is not regarding either the time or completion of papers in nearly so important a light as other national societies do. It looks as if the papers ought to be prepared about two months earlier than the present time. In most of the larger societies the receipt of papers for scheduling is at least six months ahead of the time of the meeting. This will allow better scheduling and better arrangements for simultaneous sessions which do not prevent attendance at several interconnected sessions, which occurs now.

One thing I must bring to your attention is, I think, likely to prove of considerable importance. The Society has produced a motion picture film entitled "Principles of Automatic Control". This is a device for training and education of its members that no other society has so far put to use. An interesting feature about this very valuable project is that in the long run it is likely to be much better than self-supporting.

I believe it is proper for me to congratulate the membership on what looks like a very satisfactory rate of progress, and also thank you very heartily for the privilege of serving as your president for this year.

—R. J. S. PIGOTT

Report of Executive Secretary

ISA Board of Directors Meeting, Memorial Auditorium, Buffalo, N. Y., September 18, 1950

THE Secretary's report must of necessity be brief, as at the time the report should be in the "works", the Conference and Exhibit work is so great that the time required for making a more detailed report is not available.

Society Membership

The membership of the Society now numbers 4298. This is an increase of 402 over the count made in January 1950. Table 1 shows a breakdown of the membership by Section affiliation and grade of membership as of September 1, 1950. Five deaths among the membership have been reported to the National Office, that of Mr. Peter L. Sibley of 18 Wall Street, Foxboro, Mass., member of the Boston Section; Mr. E. J. Calnan of 209 Russell Ave., St. Catharines, Ontario, Canada, member of the Ontario Section; Mr. W. M. Dodge of 407 Urbana Drive, Ann Arbor, Michigan, member of the Chicago Section; Mr. Bruce Irwin, Hammel-Dahl Company, Providence, R. I., member of the Pittsburgh Section; Mr. Stephen A. Brooks, Brooks Rotameter Company, Lansdale, Pa., member of the Philadelphia Section.

Table 2 shows membership growth by years. Table 3 shows membership changes by years and by Section.

New ISA Sections

Sections of the Society now number 52. Four new groups have been granted Charters since September 1949. These are:

Wilmington, Chartered: 12-2-49, members: 77; Panhandle, Chartered: 2-10-50, members: 43; Toledo, Chartered: 4-15-50, members: 27; Central New York, Chartered: 5-15-50, members: 20.

Visits of Secretary to Local Sections

Since the September 1949 Annual Meeting, The Secretary has attended the following Section Meetings, aside from the ISA National Executive Committee Meetings:

Sept. 30, 1949—Northern California Section Executive Committee Meeting, San Francisco.
Oct. 4, 1949—California Section Meeting, Los Angeles.
Oct. 7, 1949—Organizational meeting at Denver.
Oct. 8-11, 1949—Houston Section Meeting.
Oct. 24, 1949—Pittsburgh ISA Regional Meeting.
Nov. 28, 1949—New Jersey Section Meeting.
Dec. 5, 1949—Syracuse organization meeting.
Dec. 6, 1949—Niagara Frontier Section Executive Committee Meeting.
Dec. 7, 1949—Wilmington Section organization meeting.
Jan. 27-28, 1950—New York Section Regional Conference.
Feb. 20-21, 1950—Buffalo Allocation Committee Executive Committee and Joint Steering Committee Meetings.
March 7, 1950—Chicago and Northern Indiana Sections Joint Meeting.
May 23, 1950—Akron Section Meeting.
May 24, 1950—Meeting with Finance Committee Chairman, New York.
June 26-27, 1950—Buffalo Total Steering Committee Meeting.

Sound Slide Film of St. Louis Exhibit

In response to two News Releases sent to ISA local Section Officers, two announcements in the ISA Journal as well as listings in the Calendar of the ISA Section Activities, many letters,

Table 1. Membership of Sections, Sept. 1, 1950

SECTION	M	AM	SM	TOTAL
Akron	36			36
Albuquerque	41	18		59
Aruba	39			39
Atlanta	16	1		17
Baltimore	70	5	1	76
Baton Rouge	47			47
Boston	105			105
California	167			167
Central Illinois	33	2	1	36
Central Indiana	26	52	2	80
Central New York	18			18
Charleston	64	4		68
Chicago	234	22	86	342
China Lake	41			41
Cincinnati	62			62
Cleveland	121	5	3	129
Columbus	22	4		26
Cumberland	12	2		14
Detroit	61	2	2	65
Eastern New York	55	1	42	98
Gulf Coast	39	2		41
Houston	132	2		134
Kansas City	39	18		57
Louisville	33	2	2	37
Montreal	81		1	82
New Jersey	232			232
New Orleans	10			10
New York	182	12	56	250
Niagara Frontier	73	16	2	91
North Texas	23	1		24
Northern California	102			102
Northern Indiana	22	3	1	26
Oak Ridge	66			66
Ontario	40	1		41
Panhandle	45			45
Philadelphia	302	14	14	330
Pittsburgh	198	7	36	241
Presque Isle	17	1		18
Richland	55	10	7	72
Rochester	76	1		77
Sarnia	63	12	2	77
South Bend	2			2
South Michigan	17	6	3	26
South Texas	32	9	20	61
St. Louis	126	3	3	132
Tennessee	30	16		46
Toledo	27			27
Tulsa	87	8	1	96
Twin Cities	25	9	2	36
Washington	61	55		116
Wayne County	51	21	1	73
Wilmington	73	4		77
At Large	23	4	1	28
	3654	354	290	4298

Table 2. Increase of Membership

DATE	TOTAL MEMBERS	NUMBER OF SECTIONS
8-46	1075	21
12-46	1650	23
4-47	2121	27
8-47	2296	32
3-48	2966	38
8-48	3280	41
2-49	3762	44
5-49	3908	44
9-49	3880	47
1-50	4224	49
6-50	4300	52
9-50	4298	52

and from publicity received elsewhere —the Sound Slide Film "A Tour of the Fourth National Instrument Conference and Exhibit," was shown by June 30, at ISA Section Meetings and to other groups as follows:

Film 1, 11 Section Meetings and 8 other groups, Total 19; Film 2, 8 Section Meetings and 8 other groups, Total 16; Film 3, 4 Section Meetings and 8 other groups, Total 12; Total showings: 47.

All comments received from those who saw the films have been favorable.

Groups other than ISA Sections who have seen the film include: The Mine Safety Appliances Co., The American Medical Association, Photoswitch Inc., Standard Oil Co., Cleveland, Ohio, and General Mills Inc.

Charges made on the exhibitors who participated in the film have liquidated the expenses incurred in its assembly and in addition have supported the purchase of a recorder, projector and amplifier necessary for showing the film.

Film on Control Principles by G. F. Akins and J. H. Kowalski

The film "Principles of Automatic Control" is ready for its premier showing at this annual meeting.

Buffalo Exhibit

168 booths have been sold to exhibitors, 4 have been given to co-sponsoring societies on a complimentary basis, 13 have been allocated to Government agencies and 2 have been allotted to educational institutions.

Tentative Recommended Practice, RP5

The distribution of copies of Tentative Recommended Practice 5, "Instrumentation Flow Plan Symbols" to the entire membership has been completed.

ISA Journal Changes

Beginning with the October 1949 issue of the ISA Journal, the reporting of news on meetings from Sections under Section headings was discontinued. Since then news articles of National interest have appeared. Announcements of New Sections and a notice of deaths have appeared. The Section Secretaries Calendar has been changed to allow the incorporation of Section telephone numbers and meeting locations. Mr. McCaffery had been acting in the capacity of news editor in the accumulation of information, and the writing and editing of news articles under the supervision of the Executive Secretary.

National Office Personnel

The National Office personnel is now three, Mr. McCaffery, Miss Kiger and Miss Hoy; Miss Christoff left our employ on March 24, 1950 to marry and will be replaced as soon as a satisfactory replacement can be obtained.

To assure that most of the preprints were available at this meeting John McCaffery and my daughter Martha did considerable extra work at no expense to the ISA.

The work of the National Office on the preparation of preprints has increased beyond the capacity of the present staff due to the fact that:

1. The number of papers presented at our annual meetings has increased.
2. Speakers do not follow the instructions issued to them by the Vice President in charge of Technical Committees.
3. Technical Committees only check manuscripts for technical data and not to meet editorial requirements.
4. Many illustrations are unsuitable for reproduction.

A contributing reason to the extra demands on the staff's time was due to the fact that all papers for the Buffalo meeting were received after July 1st.

To remedy this situation, the following recommendations are made:

1. That the Publications Committee take over the collection of papers.
2. That all papers to be presented before the Houston Meeting must be received before May 1st and that no papers received after that date will be scheduled.
3. That some provision be made to furnish the necessary editorial assistance for editing the Houston papers.

I also recommend that an increase in pay for Cy Goldcamp be granted and paid for from the contingency fund. This increase is recommended on the basis of his work on Employment, which is taking much more of his time than should be expected of a committee chairman. The payment he now receives is in payment for his assistance to me in the operation of the Show and he gives excellent service for the money he receives.

I further wish to point out that more office space will be needed as the present space is quite crowded and will be more so, as more filing space is needed. This will represent an additional rent of $55.00 per month.

Society Elects 1951 Officers

At the ISA Board of Directors meeting held September 18 during the Fifth National Instrument Conference and Exhibit, the following men were elected to office and will assume their duties on January 1, 1951.

J. B. McMahon, Republic Flow Meters Company, was elected Society President. He will replace R. J. S. Pigott, Gulf Research and Development Company, 1950 President. Porter Hart, Dow Chemical Company, 1950 Vice President Supervising the Operating Division, was elected first Vice President.

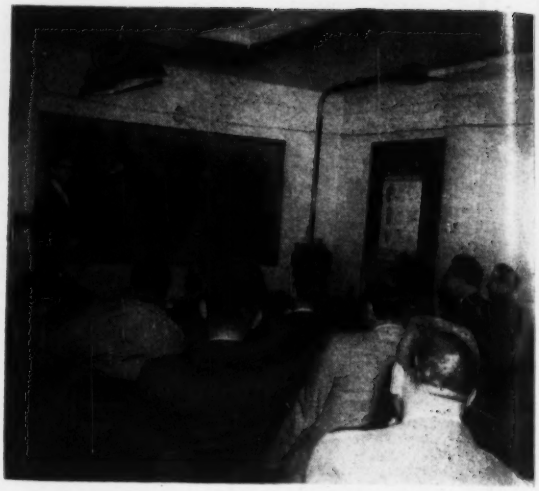
N. L. Isenhour, Carbide and Carbon Chemical Company, was elected Vice President Supervising the Operating Division. W. A. Wildhack, National Bureau of Standards, was elected Vice President Supervising the Technical Division. He will replace Dr. A. O. Beckman, National Technical Laboratories, who was elected to serve on the Society Executive Committee.

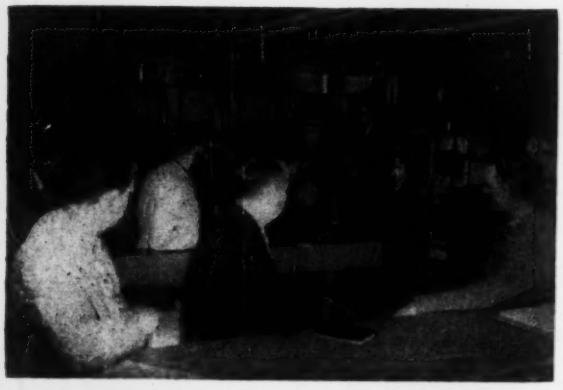
George R. Feeley, Trinity Equipment Corporation, was elected Treasurer. He will replace H. E. Ferguson, Peoples Gas, Light & Coke Company. Richard Rimbach, The Instruments Publishing Company, Inc., was reelected Executive Secretary.

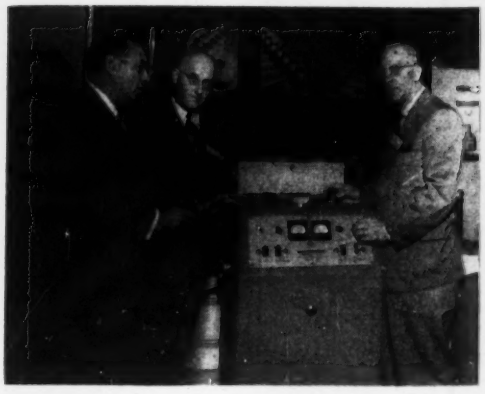
Table 3. Membership Changes by Year and Section

SECTION	CHARTER DATE	4-47	8-47	8-48	3-48	4-49	9-49	1-50	6-50	9-50
Akron	7-19-48			14	36	40	43	44	37	36
Albu.	7-16-49							43	59	59
Aruba	1-20-47	26	28	64	66	61	59	63	40	39
Atlanta	8-23-48			16	20	20	20	17	19	17
Baltimore	1-10-46	60	60	63	72	73	69	78	75	76
Baton Rouge	5-10-49								47	47
Boston	7-28-48				61	82	86	95	94	105
Calif.	1-10-46	31	47	103	160	174	164	166	177	167
C. Ill.	3- 8-48			26	33	36	30	34	36	36
C. Ind.	1-30-47	65	81	82	85	84	78	82	81	80
C. New York	5-15-50								20	18
Charleston	1-10-46	112	91	80	87	85	81	83	71	68
Chicago	1-10-46	232	245	270	269	283	299	323	335	342
China Lake	1-17-49				54	73	86	89	46	41
Cincinnati	3- 7-47	39	43	58	68	68	65	69	63	62
Cleveland	1-10-46	110	119	127	133	133	122	135	136	129
Columbus	7-16-49							28	29	26
Cumberland	4-24-46	27	31	19	18	18	15	15	15	14
Detroit	1-10-46	82	83	79	77	77	75	72	66	65
E. New York	1-20-47			58	80	81	90	105	98	98
Gulf Coast	1-10-46	26	28	46	41	43	42	45	42	41
Houston	3-16-48			82	101	105	113	126	140	134
Kansas City	1-10-46	35	38	49	47	50	53	58	59	57
Louisville	3- 7-47	41	53	38	42	38	39	40	34	37
Montreal	6-16-48			38	60	70	72	73	86	82
New Jersey	1-10-46	133	146	189	209	226	227	232	252	232
New Orleans	4-11-46	5	9	9	5	4	4	4	7	10
New York	1-10-46	122	132	150	219	218	214	221	223	250
Niagara F.	7-31-47		48	120	95	88	90	91	88	91
N. Texas	2-16-49				29	34	40	44	24	24
N. Calif.	9-10-49							91	102	102
N. Indiana	1-10-46		21	28	30	25	23	24	27	26
Oak Ridge	8-27-46	67	69	55	57	66	67	67	69	66
Ontario	1-10-46	65	61	39	37	37	43	44	40	41
Panhandle	2-10-50								43	45
Philadelphia	1-10-46	242	263	328	387	396	381	360	322	330
Pittsburgh	1-10-46	152	157	185	198	223	219	224	242	241
Presque Isle	7-31-47		2	24	21	22	22	23	19	18
Richland	1- 1-48			124	143	112	99	102	79	72
Rochester	2-16-48			60	70	72	67	70	71	77
Sarnia	9- 1-47			99	68	74	77	82	73	77
South Bend	3- 7-47	21	27	23	24	24	10	12	4	5
S. Michigan	11-11-46	42	51	45	38	39	34	33	27	26
S. Texas	11-11-46	86	50	42	46	50	46	45	51	61
St. Louis	1-10-46	68	79	82	96	104	112	141	137	132
Tennessee	1-10-46	36	23	40	43	45	41	47	51	49
Tulsa	9- 6-47			75	78	81	82	92	96	96
Toledo	4-15-50									27
Twin Cities	3-10-47		11	46	47	46	44	45	41	39
Washington	1-10-46	121	141	134	146	145	143	129	117	119
Wayne C.	1-10-46	40	41	42	41	46	45	35	27	23
Wilmington	12- 2-49							33	27	27
At Large					25	29	27	34	35	28
TOTAL MEMBERS		2121	2296	3280	3762	3908	3880	4224	4300	4298

A BUSY WEEKEND AT THE CLINIC







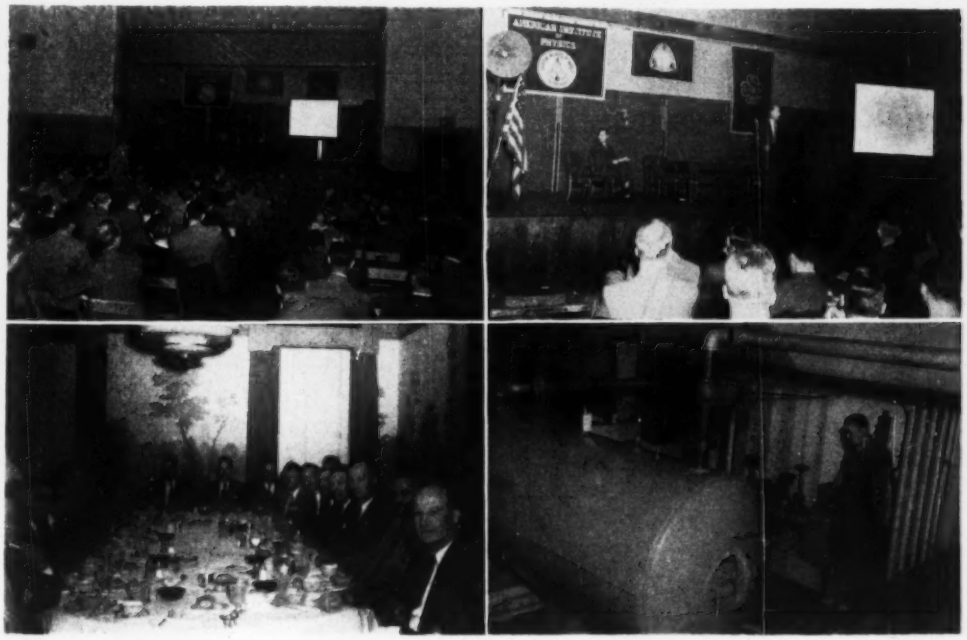
Above: R. Rimbach (left), ISA Executive Secretary, talks with Richard R. Dry (center), Director of the New York State Institute and with Otto V. Guenther (right), Institute's head of Mechanical & Metallurgical Technology.

Scenes at the Instrument Maintenance Clinic held at the New York State Institute of Applied Arts & Sciences, Buffalo.

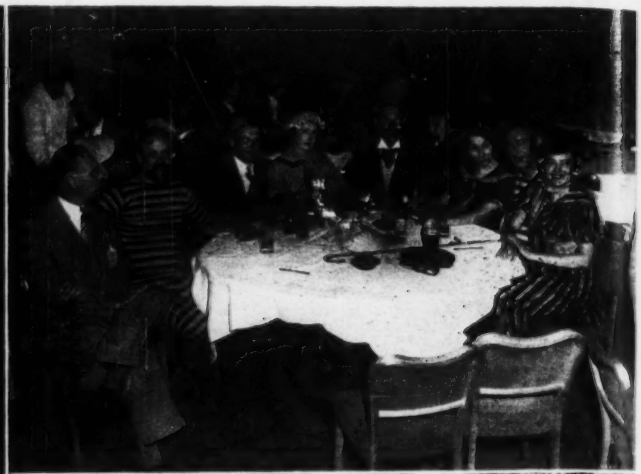
AND A BUSY WEEK FOR OFFICERS AND COMMITTEES

Above left: ISA officers left to right, back row—A. O. Beckman, W. A. Wildhack, W. L. Isenhour, Porter Hart. Front row—Nelson Gildersleeve, Richard Rimbach, R. J. S. Pigott, H. E. Ferguson and J. B. McMahon. G. R. Feeley, 1951 Treasurer, not present. Above right: Executive Committee Meeting. Lower left: Recommended Practices Committee Meeting. Lower right: Meeting of the Instrumentation for Production Processes Committee.

FOR SPEAKERS AND MEMBERS IN ATTENDANCE



Above left and right: Technical Sessions in the assembly hall. Lower left: A Speakers' and Technical Chairmen's breakfast, Hotel Statler. Lower right: Air compressor setup supplied through the courtesy of Nash Engineering Corporation for providing compressed air to exhibitors requiring it.



THE GOOD OLD DAYS—Gayiety at the Gay Nineties Party held Wednesday evening during show week.

More "Nineties" gayiety (above).

"Cigarette Girls" (right) who sold "money" in gambling room at Gay Nineties Party.

EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA, 921 Ridge Ave., Pittsburgh 12, Pa.

The following open positions were posted at the Employment Register conducted during the period (Sept. 18-22, 1950) of the Fifth National Instrument Conference and Exhibit, Buffalo, N. Y. These open positions are listed in the Employment Service for the benefit of those who may be interested and who did not attend the Conference and Exhibit. According to our records none of the positions had been filled at the close of the Conference and Exhibit. Those interested should direct their applications to the Society office.

DESIGN ENGINEERS for the development of small physical measurements devices and systems such as electronic computers, mechanical linkage computers, vibration meters, pressure gauge systems, instrument servo systems, recording galvanometers, strain gauge systems, and other electrical, electronic, mechanical and hydraulic instruments. Men with advanced degrees preferred. Employment on permanent basis rather than specific projects. Location Buffalo, N. Y. Box 331.

DESIGN ENGINEER for electrical indicating instruments. Experienced in design, tools and production problems of D. C. electrical indicating meters. Location N. Y. City. Box 332.

DESIGN ENGINEERS with at least two years mechanical product design experience to expand development and application activities of Valve Div. Experience in pneumatic field desirable but not essential. Location Philadelphia, Pa. Box 333.

DESIGN ENGINEER (or Department Engineer) must be able to plan intricate piping layouts and stress calculations for temperature and other effects. At least ten to fifteen years experience in drafting and engineering design in either refinery, power plant or process industries. Process experience preferred. Location N. Y. City. Box 334.

DESIGN (ELECTRICAL ENGINEER) B.S. or M.S. from recognized University and 3-8 yrs. experience in electronic circuit design and with instruments of analytical nature. Permanent job. Salary open. Location California. Box 335.

DESIGNERS AND DRAFTSMEN to work under Instrument and Control Design Engineer correlating all information available and make computations, layout drawings, design drawings and sketches necessary to fabricate, purchase or erect gauge and control boards. Includes instruments to indicate, record, integrate, control the operation of steam generators, turbo generators, and their auxiliaries. Permanent position. Location Detroit. Box 336.

DRAFTSMAN (INSTRUMENTS) with 3 to 5 years experience in layout work, panel design and piping layout. Salary $275.00 to $500.00 depending on experience. Location Louisville, Ky. Box 337.

DRAFTSMEN (INSTRUMENTS). Opening for two men experienced in design of small mechanisms for instruments. Permanent. Excellent working conditions. Five day week. State age, education, complete experience and salary desired in first letter. Location Philadelphia, Pa. Box 338.

INSTRUMENT ENGINEER experienced with management and production ideas. Must know instrumentation and be good designer, age no obstacle. Prefer experience in industrial thermometers, recorders, air and electrically operated controllers and dials of the mercury-vapor and liquid filled types. Location Detroit, Mich. Box 339.

INSTRUMENT ENGINEER graduate Ch. E. must have heavy experience in oil refinery instrumentation. Must be capable of preparing process control diagrams and specification for purchasing and installing of instruments. Give complete resume of background and experience in first letter. Location New Jersey. Box 340.

INSTRUMENT ENGINEERS Ch. E. graduates preferred. Must have two or more years in instrument work. Employer is large manufacturer of polychemicals. Location Texas. Box 341.

INSTRUMENT ENGINEER graduate Ch. E. or other engineer with chemical engineering experience. Must be able to do some maintenance and capable of assisting in choice of flow, temperature measurement and control equipment. Must have several years experience. Position entails supervisory duties. Location Iowa. Box 342.

INSTRUMENT ENGINEER, graduate M. E. preferred, to assist in supervision of field maintenance, shop work, and new installations. Must have several years experience on instrument maintenance and engineering, preferably in chemical plant or petroleum refinery. Location New Mexico. Box 343.

INSTRUMENTATION ENGINEER design and administration of chemical process instrumentation including supervision of instrument engineers and draftsman. Initiative on special remote control problems desired. Age 30-40. Two to ten years experience in industrial process instrumentation. Salary open. Location New York City. Box 334.

ELECTRICAL INSTRUMENT ENGINEER graduate (1950) E. E. from accredited school who has had good design preparation; or graduate within one or two years who has been working at design. For design of electrical indicating instruments which should include knowledge of design of magnetic systems and coils, and of the mechanical design of the components of electrical instruments. Salary 4500 to 5500 per year depending on experience. Location Connecticut. Box 345.

ENGINEER (POWER SERVOMECHANISMS) skilled in use of instruments for development of power servo-mechanisms and control devices of the electrical, hydraulic, or pneumatic type and instrumentation of dynamic models for wind tunnel testing. Must be thoroughly experienced. Those with advanced degrees preferred. Permanent. Location Buffalo, N. Y. Box 346.

INSTRUMENT ENGINEER experienced in watch manufacture, design, electronics. Good position with excellent future. Good living conditions. State age, experience and salary desired in first letter. Location Illinois. Box 347.

INSTRUMENT ENGINEER (INDUSTRIAL) by

Continued on page 1077

The Application of Bourdon Tubes to Pressure Indicating Devices

By MYER P. WHITE *

The design of a bourdon tube for use in a pressure actuated indicating device involves a relatively small number of considerations, most of them familiar to designers. Unfortunately the relationship between them is quite complex, and the practical limitations imposed by them are not too generally known. Our purpose is to acquaint the instrument designer with these limitations, to suggest an approach to the choice of the proper tube for his application, and to present actual examples to illustrate this approach.

The Bourdon tube can be any hollow member of other than circular cross section which has been bent on a radius perpendicular to its major axis and closed at one end. When a differential is made to exist between the pressure inside and outside the tube the tube will be stressed and a strain imposed proportional to the elastic modulus of the material. If the internal pressure is greater than the external pressure the section will tend to become circular, the longitudinal resultant will tend to lengthen the tube and the tube will begin to straighten. When one end of the tube is held rigid, the free end will move, the path of motion being approximately involute, and the deflection will be in proportion to the stress in the tube. Since the stress is proportional to the differential pressure, the movement of the tip can be used to indicate changes in pressure. Changes in temperature will cause a similar deflection in the tube, so that it can also be used for the measurement of temperature.

The selection of the dimensions of the tube, and its material, for a particular instrument is of course dependent on the characteristics desired. It is here that the complexity becomes apparent. The most efficient cross section in order to avoid stress concentration is an ellipse. The mathematical calculation for stress and deflection of an elliptical tube bent on a radius is quite complex, but it can be handled. However, the bend radius does not remain constant, and the section does not remain elliptical as the tube deflects. One end is held rigidly, and the loads are both radial and perpendicular to a cross section. In 1924 Chido Sunatani, a Japanese engineer, presented a mathematical analysis of the stress problem, that has been read by most gage designers, with the result that bourdon tubes for pressure gages are still designed in almost all cases by varying known empirical data. The futility of the theoretical mathematical approach is increased by the fact that the actual tube sections used are not true ellipses since such a shape would be almost impossible to manufacture, and the radius of curvature of the bent tube is not uniform from point to point. But we do know that changing the bend radius, the minor axis of the ellipse, the length of the tube, the angle included between ends of the tube, or other individual factors, will change the deflection rate in definite proportions — within certain limits.

We would then assume that lacking a mathematical approach we could make a tube, test it, vary the proper dimensions the proper amount and predict accurately its characteristics and its suitability for application to a particular instrument. This is almost correct, but some very important design considerations have still been neglected. First, the range of deflection within which the motion of the tip is proportional to the pressure is limited. Secondly, the power of the tube must be sufficient to absorb and deliver the work involved.

A bourdon tube is a special type of cantilever spring, and the path of the tip in deflection is similar. The deflection of each point in the length of the tube as we progress away from the rigid end is greater not only by the proportion of its distance from the end but by the increment of deflection of the previous point, so that for increasing pressures the path of the tip is approximately involute. If we confine ourselves to that portion of the involute on which the momentary radii of curvature are very much greater than the distance moved, we can consider this portion to be a straight line. Using only this straight line portion of the tip travel, we thus avoid the necessity for complex mechanical corrections for variation in deflection rate. This straight line portion of the tip travel is usually described as the range of the spring.

We have established the fact that the actual usable deflection is small. To make our instrument readable to an accuracy of value to us, it is necessary to multiply this deflection and project it on a suitable scale. This is accomplished by mechanical, electrical or optical means, or any combination of them. Friction can be reduced but can never be eliminated in the multiplying mechanism and friction must be overcome before the tube can indicate truly. Let us call this friction "mechanism drag". To evaluate the effects of mechanism drag we can return to the cantilever spring.

If the tip of the cantilever spring is resisted in motion as the spring is stressed, the deformation of the tip will not follow the anticipated path. When the resistance is rolling or sliding friction, the result is a lag which will delay arrival of the tip at its proper point for the stress in the spring. We know that increasing the size of the spring without changing the deflection rate will sensibly overcome the drag. The spring must be large enough to absorb and transmit the energy input required to move its tip through the desired path in the desired time. We know that it must be capable of exerting a force sufficiently large in proportion to the resistance so as to sensibly nullify the effect of this resistance. The same applies to a bourdon tube. The tube must be powerful enough to effectively overwhelm the drag of the multiplying mechanism that is necessarily attached to it in the instrument.

In any mechanical mechanism there must be clearance between rotating members and their bearings. In today's standard pressure gage the multiplying mechanism is a fulcrum bar with loads applied at opposite sides of the fulcrum, combined with a sector and pinion arrangement which is in effect a gear train. There are clearances between pins and link bushings, and there is backlash in the gear teeth. We use a hairspring on the smaller gear to take up the backlash and clearances. The bourdon spring must overcome the load caused by the hairspring in this application. The hairspring acts in only one direction, so in indicating increases of pressure the tube may be resisted and in indicating decreasing pressure the tube will be assisted. But we are not looking for any assistance. All we want is a true indication of how pressure some place is varying, so the tube must be powerful enough to nullify the effect of hairspring loading.

The force exerted by the tube is proportional to the pressure in it, and is the same as the force required to move it. A tube designed to move a certain distance with low pressure differential is naturally not as powerful as a tube designed to give the same move with a high pressure differential. In any tube regardless of its design, the force exerted by the tube at 1 per cent of its designed travel is only 1 per cent of the force exerted at 100 per cent of its designed travel. In practical applications the tubes are not designed heavy enough to overpower the mechanism drag at 1 per cent of the designed tip travel as this would result in an extreme overdesign at 50 to 10 per cent of the usable range of the tube. It is therefore accepted standard practice to leave off the dial that portion of the move which is not powerful enough to overwhelmingly offset the mechanism drag. This unused portion of the dial is usually called the take-up.

Each application of a bourdon tube presents its own problems. Almost invariably they can be summed up as follows, the order of importance varying with the particular application:

a. Space limitations

* Crosby Steam Gage & Valve Co., Wrentham, Mass.

Note:—Presented at the Fifth Annual Conference of the Instrument Society of America, Sept. 18-22, 1950, Buffalo, N. Y.

Statements and opinions advanced in papers are to be understood as individual expressions of the authors and not those of the Society.

b. Pressure range
c. Usable tip travel desired
d. Power, or energy which must be supplied to the driven mechanism
e. Accuracy desired
f. Special considerations such as corrosion resistance, rate of anticipated pressure fluctuation, etc.

The tube being bent in an approximately circular arc, we must think of tip travel as both linear and angular. We must bear in mind that we have in effect a cantilever beam, and we must avoid stressing our material beyond its elastic limit and causing permanent deformation or "set". The maximum variation of pressure must be such that the deflection of the tube, i.e., the tip travel does not exceed the "linear" portion of the involute. We must keep the power of the tube proportionally greater than the mechanism drag, enough so that the desired accuracy can be obtained. Our material must be resistant to corrosive substances present and must be resistant to fatigue stresses. The consideration of angularity in connecting mechanisms may well be mentioned here, although it has no bearing on the design of the tube itself. Connecting linkages should be as close to perpendicular to each other as can be arranged so that the direction of motion of a link will be the same as the force exerted by it.

Let us take as an interesting example of the application of a bourdon tube to an instrument, the Ashton Wheel Press Recording Gage. This instrument is built for a specific purpose, and as in all special applications, the design depends on what the instrument must do and how it will be treated.

Railroad car wheels, street car wheels, some materials handling truck wheels, are pressed on to their axles. Over the years of use certain standards have been set up for tightness of fit, to avoid cracking a wheel and to avoid wheels falling off their axles when in motion. It is customary to press the wheels onto the axles in an apparatus called a Wheel Press, which consists of a frame for holding the wheel and axle and a hydraulic ram to exert the force necessary to overcome the interference fit. Experience has shown that for certain types of cars, a force of 100 tons should be used in pressing on wheels. The diameter of the wheel bore is 6 in. and its length is 11 in. A ridge can be machined on the axle that will require 100 tons to be crushed and the wheel will then go in smoothly. It will also come off just as easily. What is wanted is a smooth bore, not tapered, and a smooth shaft, not tapered and slightly larger than the bore. If the parts are properly machined, the force required for pressing will increase uniformly as the wheel is pressed onto the axle. To use the terminology of the railroad shops, the load must be proportional to the length of fit. The press is located in the wheel shop, where vibrations due to other work are large and frequent. The pumps delivering fluid to the hydraulic rams are another source of vibration. The work in the shop is heavy and the men are necessarily strong. The wheel shop is no place for a delicate mechanism.

We said the force exerted by the ram should be proportional to be wheel fit, but how can we prove it? We are using a hydraulic ram. Isn't the force of a ram proportional to the pressure on the ram? Then a bourdon tube application is indicated. The force being proportional to pressure, we can indicate pressure with a standard pressure gage and show force units on the dial. The press operator can now watch his gage, and if the gage hand moves uniformly up to the proper point on the dial he can assume that the fit is proper. To convince the shop foreman that the fit is proper requires a record of the variation of pressure with length of fit. The instrument must have a means of indicating pressures and a means of recording their relationship to wheel fit. The recording must be permanent so that it can be referred to in case of question at any time.

The Ashton Wheel Press Recording Gage was designed to utilize a bourdon tube as a pressure trensmitting and indicating device, with suitable linkage to make a simultaneous recording in rectangular coordinates of the pressure in the hydraulic cylinder and the distance the wheel had moved onto the axle. For a perfect fit, the line drawn by the recording pen on the chart paper should be a straight line starting at the origin and extending to a point corresponding on one axis to the full length of the shaft hub, on the other axis to the desired ultimate press load or pressure. Both the indicating and the recording mechanisms must be driven by the same bourdon tube, which means that the mechanism drag will be large. The problem is to design an efficient recording and indicating mechanism, and a tube powerful enough to drive it without losing accuracy. The tolerance on wheel fit is plus or minus 20 tons or plus or minus 20 per cent. A guaranteed accuracy of 2 per cent is sufficient for this tolerance. The gage must be designed to better this accuracy. So far no space limitations have been imposed. Fortunately, having been in the gage business over fifty years at the time this instrument was designed, the engineers knew that they could refer to their accumulated experience and find a suitable tube. The mechanism was then the first thing to design, for that would determine the drag and the space limitations.

A roll chart five in. wide was chosen, to be driven by the ram plunger through a series of gears and chains, in such a manner that the travel of the chart would correspond to the length of wheel fit. To transfer the tip movement to straight line motion of a pen in a line perpendicular to the direction of chart movement a linkage was designed to be connected to the tip, with suitable means for holding a pen. The arrangement of the gear train and linkage determined the space available for the tube.

It was now necessary to determine the possible variations in ram pressure and ram size that might occur in the presses made by various manufacturers. For a press using a 16 in. diameter ram a pressure of roughly 1985 psi. will deliver 200 tons of force at the wheel. If the ram diameter is 8 in. a pressure of 7950 psi. would be needed to deliver the same number of tons. A car wheel is pressed on with 80-120 tons. If poorly machined, this may become as much as 180 tons, so the instrument must be designed to register as high as 200 tons to be safe. Locomotive wheels are pressed on with a higher load, so in a like manner a 400 ton instrument is needed. A very thorough investigation showed that the pressure available or needed varied between 1500 psi. and 8000 psi. for various presses and wheels. This pressure range immediately ruled out bronze tubing, and we knew we should start with a heavy steel tube.

We manufacture pressure gages, using a heavy steel tube, for a pressure variation of 0-8000 psi. The length of the tube is $6\frac{1}{2}$ in. bent on a mean radius of 1-7/16 in. The outside major diameter of the elliptical cross section is .55 in., the diameter is .422 in. and the wall thickness is .05125 in. The tip travel for the usable range of the spring is 3/32 in. The power of the tube is easily sufficient to drive the standard pinion and sector linkage used in the gage, with excellent accuracy and rapid response to small or large pressure changes. We know that to build a pressure gage for 0-1500 psi. we use the same tube dimension except for a much smaller wall thickness and a smaller minor diameter. The mechanism drag will be the same regardless of the pressure used, so our tube for the lowest pressure, which would be capable of exerting the smallest force, must be powerful enough to drive the mechanism with speed and accuracy. We can make a more powerful tube by increasing the major diameter and varying the other cross section dimensions to maintain the moment of inertia, or we can lengthen the tube, which will also increase the "move" of the tip. Examination of the linkage we have decided to use, shows that a longer move would be advantageous, so we increase our tube length to 12 in., increasing the bend radius so that the angular length is unchanged. We increase the major axis of the ellipse, increase the wall thickness correspondingly, and leave our final adjustments to be made in the minor axis, since once the tube has been made this is the only dimension that can be changed. We use threaded ends on the tube to make sure it will not blow out of its socket, and seal weld or braze for pressure tightness.

Investigating the market for this instrument shows that we cannot economically buy preformed or extruded tubing. The tube is then designed to be bored from solid stock. Since we are actually designing a series of tubes to cover the range of 1500 to 8000 psi., we plan to use about eight sets of dimensions, with the wall thickness of the tubing the varying dimensions. It is easier to manufacture the tubes if we hold the inside of the tube to a constant size and vary the outside with the wall thickness. In this way the tubes can all be bored and reamed to the same diameter and the outside

dimension can be ground to the size required for the individual customer's ram diameter and pump pressure. From here on the rest of the design is a matter of cut and try. We know our tube is close to what will be needed, so we can build up a sample instrument, determine the exact amount of tip travel required for the length of chart reading wanted, adjust the minor diameter (the moment of inertia of the section) for this tip travel and make the other final adjustments to the mechanism, and start our breakdown test.

First the tube itself is given a whip test, which consists of applying a pulsating load of from 20 to 100 per cent of its maximum design load at 100 pulsations per minute. If the tube neither breaks nor takes a permanent set at the end of what is considered a life time of normal use, we know that this part of the apparatus is satisfactory. We submit the entire apparatus to a wear test to determine weakness in the design, we review the working conditions of the application to determine that all contingencies have been proved for and can then send out a unit for a shop test. The design is now complete, with the exception of the changes still to be made at the customer's suggestion and at the suggestion of the Sales Department.

Another example of the use of an extremely powerful tube for the sake of extreme accuracy is the Ashton Master Pilot Gage. The linkage is somewhat more complex than the standard gage linkage, as the multiplication of tip travel is greater than normal, but the large double steel tube is used primarily to develop power so great as to make the mechanical drag completely inconsequential, and the finished gage is immediately responsive to even slight pressure differentials.

Another case is that of the vacuum test gage in use at the Crosby factory for calibrating vacuum gages which has an extremely wide tube on a large radius, and drives a 12 in. pointer with such sensitivity that it detects the momentary surge in the vacuum chamber when a reciprocating pump is building up to vacuum.

Bourdon tubes can be used to make and break electrical contacts, to tip toggle switches, to drive self synchronous meters for remote-reading indicators. They can be reversed so that mechanically moving the tip of the tube will deliver a pressure surge to a very sensitive electrical instrument, for the internal volume of the tube varies with the tip position. The applications for bourdon tubes are innumerable, but the same principles must be used in their design, they must be strong enough to withstand the imposed stresses, they must be sensitive enough to transmit the imposed stresses through a mechanism without being affected by it.

Process Monitoring Systems

By E. J. GRACE, Jr. *

The increase in size of process units together with the ever mounting dependence on instrumentation to correlate all functions of these huge installations have posed many problems for the instrument engineer in recent years. One of the most exasperating of these has been the matter of measuring at a central point the miscellaneous temperatures, pressures, levels, and flows that are not critical in the operation but are of great importance to the operator or engineer in determining the optimum operating condition of various pieces of equipment such as heat exchangers, pumps, and compressors.

In the past it has been the general practice to convert the various physical measurements involved to electrical units and run wires to a central point where a multitude of key switches was made available for the operator to select any particular point for measurement.

With an ever increasing number of points to measure, the space requirements for indicators and key switches became prohibitive.

For an installation of 1000 points, there is no practical method of arranging indicators and key switches that will permit an ambidextrous operator to press the switch handle and still be in a position to see the indicator. Duplication of indicators was necessary.

The problem of wiring and conduit arrangement was even more difficult—to say nothing of spares and future additions. Faced with a requirement for between 500 and 1000 indicated temperature points and a limited panel space, an investigation into the use of circuits and equipment similar to that used in telephone work was instigated.

An analysis of many process units indicated that the best system would be one where a switching unit that would accommodate 10 points could be installed near the points of measurement with short leads from the unit to the measuring devices and then a common two-wire bus picking up all the switching units and returning to the indicating instrument.

The first complete system was designed and built by the Sun Oil Company and accommodated 400 indicating temperature points. All subsequent systems have been built by the Panellit Company.

The various systems which are described in this paper each contain 3 separate circuits; the selecting circuit which operates at 45 volts d.c., the measuring or controlling circuit, and the checking circuit.

The stepping switches have been identified by their position in the digital system and are referred to as hundreds, tens and unit switches. The measuring device is connected only to the unit switches.

DIAL SYSTEM

The type of circuit is relatively simple and is shown diagramatically in Fig. 1 for a maximum of 1000 circuits. This requires the operator to dial three figures, the first two operations of the dial select a particular circuit through the switches, the final dial operation connects a measuring device to the common bus. Note that the measuring circuit is only through the last stepping switch and does not pass through the other two switches in the system.

One feature of this system permits arrangement of the thermocouples on the stepping switches in such a manner that the operator may dial the lowest point on any unit switch, such as 321, and then run through the next

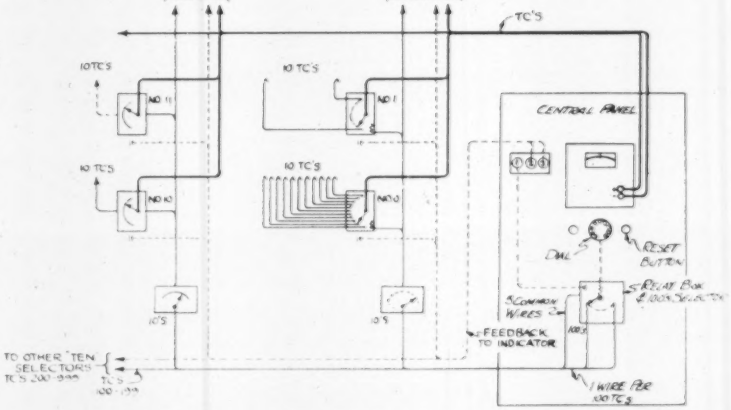


Fig. 1 Dialing System

*Sun Oil Co., Philadelphia, Pa.

Note.—Presented at the Fifth Annual Conference of the Instrument Society of America, Sept. 18-22, 1950, Buffalo, N. Y.

9 points by adding one impulse each time.

To clear the system for the next reading; the operator must push a release button that resets all switches, that have operated, to their normal open or "homed" position.

Unlike a telephone system, wrong numbers or improper dialing must be brought to the attention of the operator.

Two systems have been developed to meet this requirement.

(1) The use of a resistance network with three indicating voltmeters to show the position of each digital unit—hundreds, tens, and units.

(2) An electrical impulse fed back from a stepping switch to an identical stepping unit to which has been attached a numbered segment that indicates the number of impulses delivered to that particular stepping switch from the remotely located unit. Here again three units are used to show the position of the digital unit.

The resistance system is used in those monitoring systems where the impulse is supplied mechanically, such as an automatic scanner which operates unattended. The feed back impulse is preferred in those systems where the selection is made manually, such as the dial system.

In those installations where two types of thermocouples are used, an automatic switchover circuit is used which permits the operator to view only the correct scale for the type of thermocouple that is connected in the circuit.

BASIC UNIT

The basic unit of the system is a 10 point stepping switch with three banks of gold plated contacts. An impulse coil drives three contact fingers. Each impulse advances the switch one point and is capable of receiving up to 30 impulses per second. A release coil allows the fingers to return to the open position through a spring drive whenever the release coil is energized. An additional contact is operated by the impulse coil armature when the impulse feed back system is used.

The stepping switches are mounted on a bakelite panel which in turn is mounted on a steel panel with the necessary terminal blocks and the entire assembly is factory wired with necessary extension leads or copper wire, depending on final service. To date these unit assemblies have been wired for chromel alumel, iron constantan, and copper constantan thermocouples and copper for pressure transducers or motor operation.

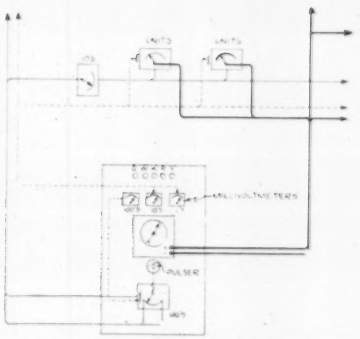


Fig. 3 Multiple Continuous Temperature Indicator

SCANNING SYSTEM

The scanning system is basically the same as the dial system except that the manual operation of the dial is replaced by a timed impulse occurring every few seconds. This system is shown in Fig. 2. An intermediate switching circuit is interposed to reset the various tens and unit stepping switches as the scanner proceeds through its sequence.

The total number of circuits scanned is variable between ten and eight hundred. The measured points are fed into a self-balancing indicator with alarm or control mechanisms attached which may stop the progress of the scanner until it is manually reset by the operator.

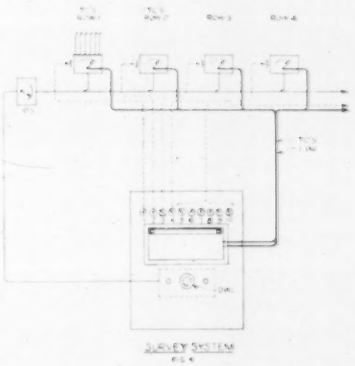
The resistance type of position indicator is used with the scanning system. At the present time one scanning system on 160 tube wall temperatures has been in operation for seven months, twenty-four hours each day without any interruption.

CONTINUOUS INDICATOR

The need for temperature indication on a graphical panel produced the continuous indicator. In this monitoring system a departure was made from the stepping switch with release coil to a switch with continuous circular drive, having five switch banks and twenty contacts per bank. The system is shown in Fig. 3.

Two of the switch banks connect thermocouples to a self-balancing indicator, the other three banks connect selsyn motors to a master selsyn which is positioned by the measuring drum of the indicator through a simple cam arrangement.

A motor-driven impulse timer controls two circuits, a d.c. circuit that advances the rotary stepping switch and connects a thermocouple to the self-balancing indicator, at the same time connecting a slave selsyn to the master selsyn in the indicator. A few seconds later, at which time the indicator comes to balance, a.c. power is applied to the selsyn circuit so that the slave will synchronize with the master selsyn. a.c. power is then removed and the next d.c. impulse given. Thus, one self-balancing indicator is used to continuously indicate twenty points on separate indicators. The cam drive of the master selsyn makes possible a scale expansion of the three inch indicator in the center of the scale to the point where 5° can easily be read on a range of 500° to 1500° F.



SURVEY SYSTEM

One process required the periodic comparison of eight temperatures in the same plane at ten different zones in a vessel and to continuously record the highest temperature in each zone.

Here the dial system was used with the variation that the output of a stepping switch was continuously connected to each point of a ten point recorder representing the ten zones; and eight thermocouples connected to the points of the stepping switch. The position of the stepping switches was indicated by the resistance method, using ten small indicators located immediately above the ten point recorder. The system is shown in Fig. 4.

With the addition of a few standard relays, any recorder point can be switched to any one of its eight thermocouples without disturbing the setting of any of the other points. At all times the arrangement of thermocouples connected to the recorder is indicated to the operator and is logged on the chart using a two digit system.

CONTROL POINT SETTING

The use of a standard dial system as a means of setting the control point on remote pneumatic controllers has many interesting possibilities.

In this application selsyn motor drives are used for setting the control point in the remote controller. One master selsyn in the control room can be connected to any one of a large number of slave units and power applied to the system after the circuit has been set up.

In this case the master selsyn synchronizes with the slave driver, since the latter is operating through a gear train.

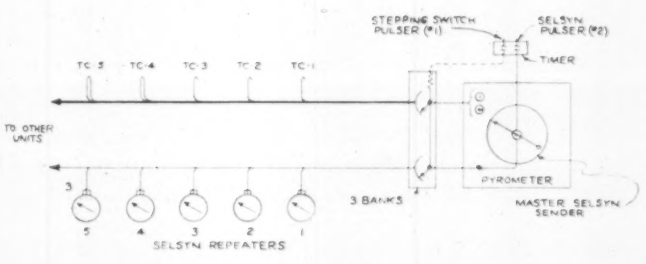


Fig. 2 Scanning System

Electrical feed backs into three common buses to self-balancing indicators show the controlled variable, the control point setting and valve air pressure or position.

REMOTE OPERATION OF PUMPS

A system for remote selection of pumping units has long been needed to complete the instrumentation of large process units. Whenever a pumping unit has failed, it has been necessary for the operator to leave the control house and manipulate valves before a spare unit can be brought into service.

Using the dial system, the circuit is set up for a particular pump and the starting button pushed, which initiates a modified sequence control circuit to open an electric-operated suction valve, check suction pressure, start motor or turbine, check discharge pressure and finally open an electric-operated discharge valve. All operations in this sequence are checked by a resistance system and indicated in the control room on a common indicator for all units. This indicator is fed by a common bus system, since only one unit is connected to the control and indicating circuits at any time.

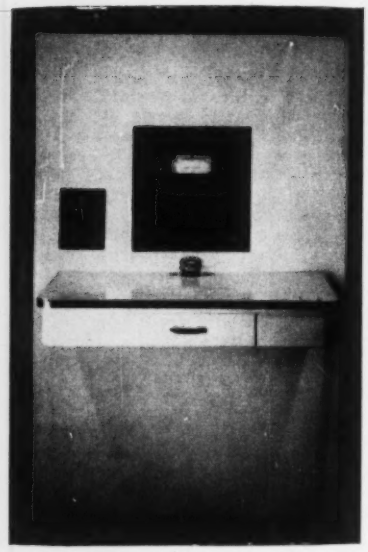
The system described here is a proposal and has not yet been installed.

At the present time there are 7 dial systems in operation, 1 scanning system, 4 survey systems, and 1 continuous indicator with 16 selsyns. The total number of measured variables in all these systems exceeds 1600.

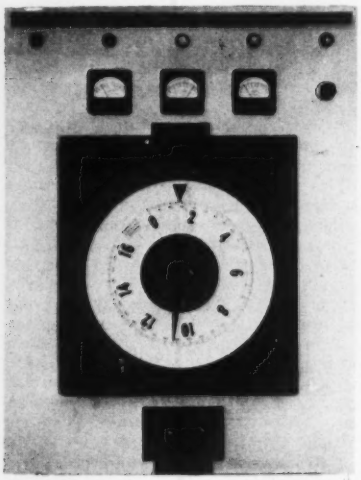
There has not been one service adjustment made on any of this equipment since it was placed in operation. Some units have been in constant operation for 18 months in hazardous and corrosive atmospheres without any contact trouble.

One feature of all systems described here require special mention. All switching is accomplished with the operating contacts carrying no load or potential.

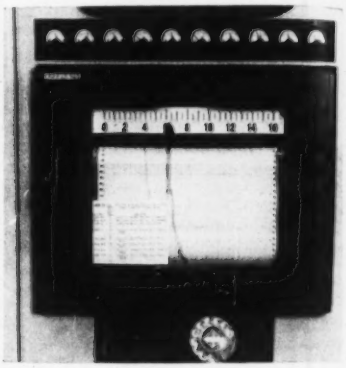
Savings in wire, conduit, fittings, labor, and panel board space becomes appreciable in large installations of 200 points or more, using this system of local "unit" selectors.



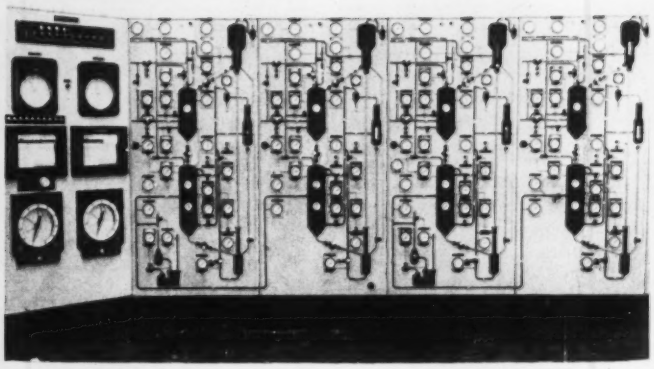
Arrangement of components of a board mounted dial system.



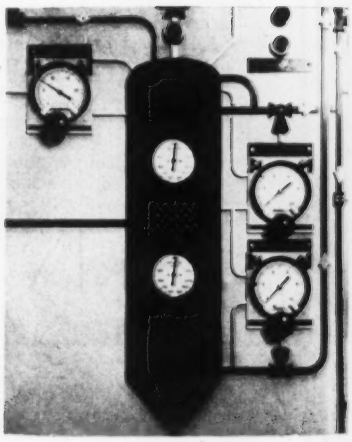
Arrangement of panel mounted units of continuous scanning system. Indicators at top show number of thermocouple connected to self-balancing temperature indicator. Button below indicator places scanner in operation after alarm condition.



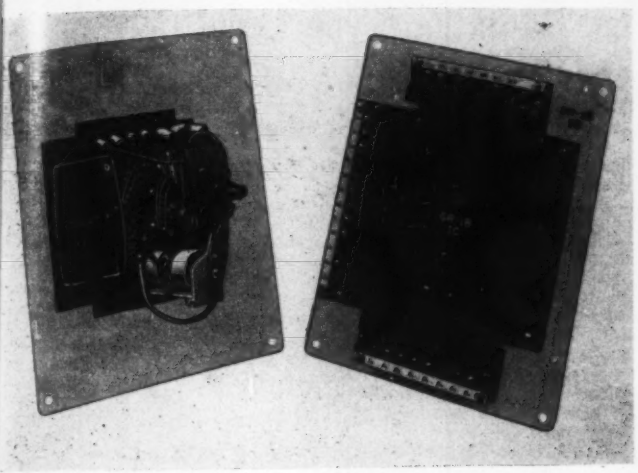
Temperature survey system. Small indicators at top show number of couple connected to recording point of instrument below. Dial and buttons below permit operator to make any selection required. Any point may be reset without disturbing other circuits.



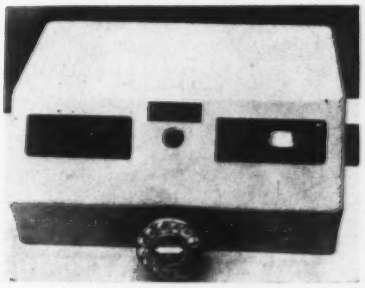
Panel arrangement of both standard and graphic units showing survey systems on left panel and continuous indicating units in vessel outlines on graphic panel.



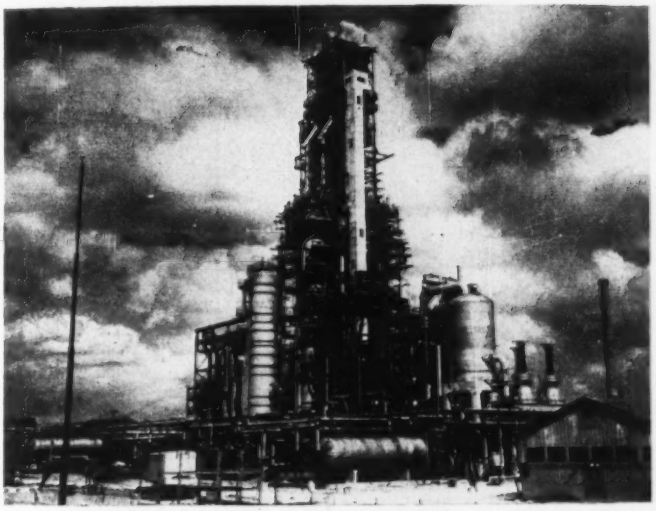
Two units of a continuous multi point indicating system on a graphic panel. Scale expansion shown here permits high accuracy in operating range of small diameter indicators.



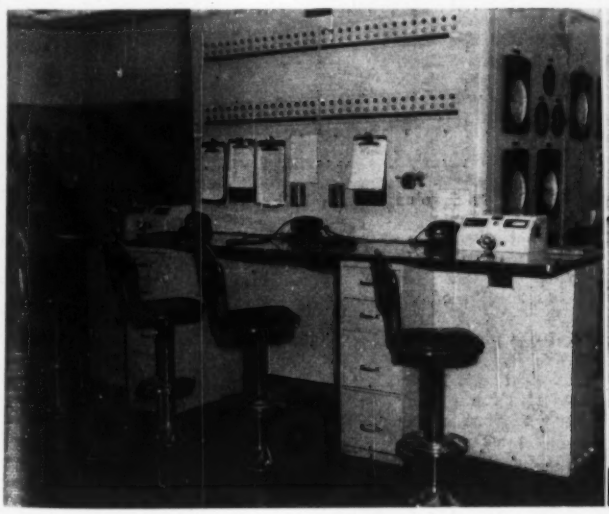
Basic stepping switch for various monitoring systems.



The dial system as it appears on a console. Indicator at left shows number of thermocouple connected to a self-balancing indicator viewed on the right through an arrangement of prisms. Indicator is located below the top of the console. Knob at right adjusts the angle of prism to suit operator's height.



The Multi Reactor Houdriflow unit in the Toledo refinery of Sun Oil Company where much of the process monitoring equipment described in this paper is installed.



Arrangement of console accommodating two dial systems, phones, alarm indicators and filing space in a very compact arrangement (left); and a Dial System in operation (right). Low silhouette allows operator complete view of entire board while checking any operating condition.

Development of Wide Range Radiation Type Level Control for the Houdriflow Catalytic Cracking Process

By E. J. GRACE and O. W. GRAHAM *

The Houdry Process Corporation with the cooperation of the Sun Oil Company has recently perfected an advanced catalytic cracking process. As a necessary part of the development of this process a suitable catalyst level indicator and control system had to be procured. All existing mechanical systems were examined and judged unsuitable. Of the non-mechanical systems, the Gagetron, manufactured by Instruments, Inc., of Tulsa, Oklahoma was selected as showing the most promise. The development of this Gagetron to meet the special requirements of this new process called the "Houdriflow" is the subject of this paper. In order to understand the problems involved a short description of the different catalytic cracking processes is in order.

These processes operate on the principle that certain natural and synthetic substances act as catalysts in the cracking of petroleum products, enabling this reaction to be carried out at much lower pressure and temperatures, and having the added advantage of producing a higher octane gasoline than the older thermal method. In all these methods the necessary procedures are, first, to bring the feed oil and the catalyst together in a reaction chamber at a temperature of approximately 850° F. and at pressures which may vary widely, but which are usually less than 85 psi; next, separating the catalyst from the cracked vapors and removing the carbon deposit from it so that it may be used again. This is accomplished by heating the catalyst in the presence of air, and sometimes steam, to a temperature which will burn off the carbon. The temperature is usually held in a range from 1000° F. to 1350° F. since a higher temperature may injure the catalyst. The differences in these processes are found in the manner in which they accomplish these functions.

The Houdry Fixed Bed Process was the first commercially successful one. It was put in use in 1936. In the latest version of this process, the catalyst is contained in layers or beds in three chambers. A system of valves enables these to be alternately charged with feed oil, reactivated, and cleared of burned gasses. The Houdry Process Corporation licenses these units.

The Cycloversion Process is similar to the Houdry Fixed Bed in that it uses fixed bed catalyst chambers, two in number. The Cycloversion, however, uses water vapor in the feed oil which reportedly increases the octane rating, and controls the temperature curing the reactivating cycle by varying the proportion of air in a superheated steam-air mixture which is blown through the catalyst chamber. The Cycloversion process is licensed by the Phillips Petroleum Company.

The Fluid Catalytic Cracking Process is so named because it uses a finely powered catalyst which takes on the physical properties of a liquid and can be made to flow through pipes. The feed oil is heated, mixed with the catalyst, and forced into the reaction chamber where it resembles a boiling liquid. The spent catalyst is drawn off at the bottom and blown through a pipe into the regenerator where it is reactivated, drawn off into the feed oil vapor. This is a continuous process. This process is licensed by Universal Oil Products Company.

The Thermofor Catalytic Cracking Process is a continuous process using catalyst in pellet or bead form. The catalyst is elevated by mechanical elevators to the top of the reactivator, called the kiln, and to the top of the reactor. The action of the process is similar in other respects to the Fluid process. The Houdry Process Corporation licenses T.C.C. Units.

The new process called the Houdriflow uses pellet or bead type catalyst, but differs from the T.C.C. process in that the reactor is placed directly above the regenerator. Thus, it is necessary to elevate the catalyst only one time during its cycle. The elevation is accomplished by a large volume, low pressure air lift. In a typical installation of this type catalyst circulates at the rate of about 250 tons per hour. With such a flow rate it is apparent that level control at different points in the system is very necessary. If stoppage should occur at any point, it would require only 10 minutes to accumulate 40 tons of catalyst.

In April 1949, Mr. E. J. Grace of Sun Oil Company and Mr. D. B. Ardern of Houdry Process Corporation conducted a preliminary investigation of the Gagetron in relation to its application to the Houdriflow Process. They concluded that the instrument could be successfully applied to measure catalyst level. They also pointed out several other proved and potential uses, such as liquid level and liquid interface level control, and in general, problems involving density measurement. They were of the opinion that the Gagetron, at that time, required further development in order to meet their requirements and recommended that a research project be undertaken to investigate the possibilities of this method. To follow the results of this investigation it is necessary to understand the working principles of the Gagetron.

The Gagetron is an electronic instrument utilizing the penetration of gamma radiation through various materials for measurement purposes. The number of gamma rays from a given size radioactive source that are detected by a counter is a function of the type, density, and thickness of different materials interposed between the source and counter, and the distance between these two elements.

Thus in level measurement, where the distance between the gamma ray source and the counter tube and the thickness of the vessel walls are fixed, the intervening materials may be catalyst and air, liquid and vapor, such as oil and oil vapor, or two liquids such as oil and water. Any change in either density or thickness will cause a corresponding change in the number of gamma rays reaching the counter. If the density is constant, then the variations in ray count may be calibrated in terms of depth or level of the intervening material. In a similar manner changes in density are detected when the material thickness and type are constant.

The source of gamma ray radiation used in the apparatus in 99.8 per cent radium chloride in approximately 1 mg. units, each contained in a pure platinum capsule. The half-life of this material is 1,580 years. Therefore, the strength of the radiations may be considered constant for all practical purposes. All alpha and beta radiations are stopped by the platinum capsule and only gamma rays are emmitted. Radon gas is produced as a fission product and may build up to considerable pressure inside the capsule.

The counter in use at that time consisted of a brass cylinder with an insulated tungsten wire through the center of the cylinder. It was of the self quenching type, filled with a mixture of argon and ammonia. This type has been replaced by another for reasons which will be explained later.

Briefly, the action of a Geiger counter is as follows: When exposed to radiation, the gas inside the counter becomes ionized. The central wire is positive in respect to the outside cylinder. The electrons which result from the formation of ions, travel toward the central wire. The voltage gradiant and gas pressure are such that these electrons are able to cause other ions to be formed. This action continues until a cloud or avalanche of electrons hits the central wire. With 950 volts across the counter, it is possible to obtain a 40 volt pulse across a 10 megohm series resistor. A corresponding number of heavy positive ions are also formed. They travel at a relatively slow rate toward the outer cylinder wall. As they approach the outer wall, some electrons may be pulled off and gain considerable kinetic energy before combining with positive ions. If this happens, ultraviolet rays may be emmitted which could cause ionization and thus create another avalanche. To prevent this, two methods are available. In one, called a self-quenching counter, a small amount of gas which is highly absorbant to ultraviolet but which does not ionize under its influence, is used. The other method makes use of an electronic circuit which lowers the voltage below the

* Sun Oil Co., Instruments Inc.

Note:—Presented at the Fifth Annual Conference of the Instrument Society of America, Sept. 18-22, 1950, Buffalo, N. Y.

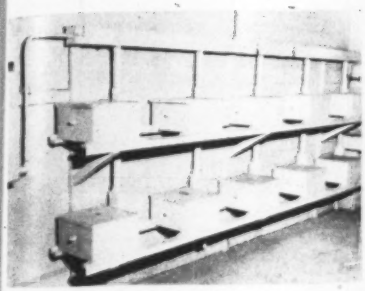


Fig. 1. GAGETRON Power Supply and Amplifier Units.

value necessary for avalanche formation until the positive ions have been cleared from the gas.

The electronic circuits associated with the counter in the Gagetron include an integration circuit which produces a voltage proportional to the counting rate. This voltage may be made to do various things such as activate a meter, recorder, or control device.

The investigation of the Gagetron was carried out by the Foudry Process Corporation in cooperation with Sun Oil Company and Instruments, Inc. and was completed by January 1950. The first serious difficulty encountered was due to temperature. The counter then in use was found to be too sensitive to changes in temperature and to suffer permanent changes in operating characteristics when subject to heat cycles encountered in refinery installations.

Commercial counters were found to be equally at fault in this respect. Every available counter suitable for gamma ray detection was tried. Extensive experimenting and research was carried out in an effort to remedy this, resulting in a counter which has an entirely satisfactory behavior in this respect. The life of this counter cannot be predicted at this time but is showing promise of being extremely long. It is of conventional construction except that it is filled with hydrogen and used with an electronic quenching circuit. All failures in the seven months that this counter has been manufactured, have been due to manufacturing faults or to failure of the quenching circuit.

The second big problem encountered was the limited control range of this instrument. To maintain the same amount of radiation at the counter as the distance between the source and the counter is increased, the amount of radium must be increased in proportion to the square of the distance. For economic reasons the control range was limited to 2 to 4 ft. A small increase had been obtained by using two sources with the counter located midway between them, but this did not approach the then desired range of 20 ft. Another disadvantage was the non-linearity of the response in regards to change in level.

During the preliminary stages of the investigation the theory underlying the absorption of the gamma rays was outlined and developed into readily usable engineering terms. Absorption coefficients were determined for steel and catalyst and a means of estimating coefficients for other materials was checked. A method was worked out in terms of the Gagetron response which would enable one to determine with a fair degree of accuracy the effect of each factor independent of the others in terms of meter deflection.

This was accomplished in the following manner: first, the response of the apparatus was checked to see if the meter reading obeyed the inverse square function as the distance between the source and the tube was varied. This was found to be the case within a certain range of the sensitivity and zero adjustment controls. A particular value of sensitivity was chosen and defined in terms of response to a given amount of radium at a given distance and all subsequent data taken under these conditions. A family of response curves were plotted on 3 cycle by 1 cycle log paper on which it plotted as straight lines. The meter reading vs. distance was plotted for different amounts of radium from 1 mg. to 30 mg. in steps of 1 mg. The actual plotted meter readings were from 0 to 100 but the lines were extended to give apparent meter readings to 10,000. This data was taken

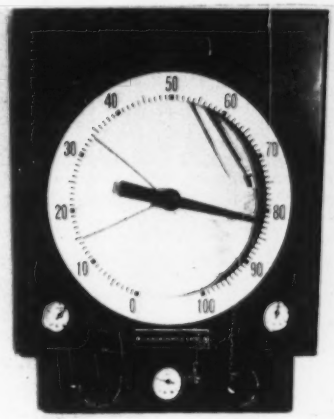


Fig. 2. Instrument recording, by means of a Gagetron, the catalyst level in a Houdriflow reactor.

with air as the medium between the radium and the counter.

Next, the absorption coefficient of various materials was measured with the apparatus and found to agree with theory and proven data. This data was plotted as straight lines on semi-log paper as percent transmission vs. inches of materials.

A correlation was found between the absorption coefficients of the different substances. The unknown absorption coefficient K of a substance may be approximated as it is directly proportional to the atomic number and to the number of atoms in unit volume. A number which is proportional to the number of atoms per unit volume may be obtained by dividing the density of the material by the atomic weight. As an example, suppose the coefficient of steel of density 7.86 gr/cc and atomic number 26 and atomic weight of 55.84 has a coefficient of .37 found from actual measurement in the manner outlined. Suppose further, that we wish to estimate the coefficient of a catalyst

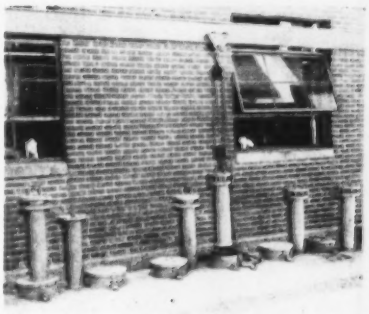


Fig. 3. When not in use, radium is stored in lead lined cylinders which are lowered into underground wells.

whose average atomic number is 10 and atomic weight is 20. The density per mole for steel would be .140 and for the catalyst .037. Then

$$.37 \times 10 / 26 \times .037 / .140 = .0377$$

for the coefficient of absorption for the catalyst. To plot the percent of transmission, use two cycle semi-log paper with the log side labeled "Percent Transmission" from zero to 100 and the other side labeled "Inches of the Material." Starting at 100 percent and zero inches, plot a line with a slope of -K (coefficient of absorption). The percent of transmission may then be read from the graph.

To calculate the reading on the Gagetron for a particular set of conditions, the apparent meter reading is obtained from the graph of meter reading vs. feet from radium to counter. If there is more than one source, the effects are additive. The product of the above apparent meter reading and the percents of tranmission for all the materials in between the counter and the source is the approximate meter reading for the particular set of conditions.

The results of these investigations were tested at the refinery of the Sun Oil Company located at Toledo, Ohio. This refinery consists of four Houdriflow units, each unit having a reactor-kiln tower and surge hopper. Two catalyst feed bins are provided for the four units. A total of 10 Gagetron Level Controls are used, one on each reactor, one on each surge hopper and one on each feed bin. The feed bins required a 20 ft. control range, the surge hopper 35 ft. By the proper placement of the radium sources, linear control has been achieved. In addition to the radium, each installation has a Geiger counter and preamplifier unit in an explosion proof housing, mounted directly above the radium on the six wide range control units. All counter units are connected to power supply-amplifier units by cables which may be as long as 600 ft. The ten power supply-amlifier units are shown in Fig. 1.

Each of these Gagetron units supplies a voltage output which is proportional to the counting rate of the Geiger counter. This voltage controls a combination recorder and pneumatic control unit as shown in Fig. 2 which is located in the main control room. This unit records level and controls the valves or other apparatus in any desired manner.

Fig. 3 shows the method in which the radium is stored in safety when

it is necessary to remove it from the vessels for any readon. The radium is inserted into the vessels through commercial fittings called Thermo-Wells. The radium is contained in the end of metal rods which are inserted into these Thermo-Wells. The rods are transported to and from the place of installation in the lead lined cylinders shown in Fig. 3.

Fig. 4 shows a chart from a recorder on one of the catalyst feed bins. The range of control is 20 ft. Each 10 unit interval on the chart represents 2 ft. in depth of catalyst. The chart was started at 11 A.M. and shortly thereafter, the automatic control was disengaged and the level of the catalyst was changed at a rapid rate. The results were checked for accuracy by hand gauge and found to be accurate. The chart shows the rapidity at which the Gagetron follows sudden changes of the order of 18 ft. in depth. The unit was put on automatic control at 4:30 P.M. For the remainder of the chart the level was maintained at a 20 ft. depth without noticeable variation. The sharp radial deflections occuring roughly at hourly intervals are caused by the automatic recalibrating circuit of the recorder.

With proper arrangements of the counter or counters and the sources, the maximum range of control is practically unlimited. The smallest increment of thickness or depth which can be detected is determined by a number of factors, the most important of which is the total range covered. For instance, if the material is steel and the range is one inch or less, differences in thickness on the order of .010 of an inch or less may be detected.

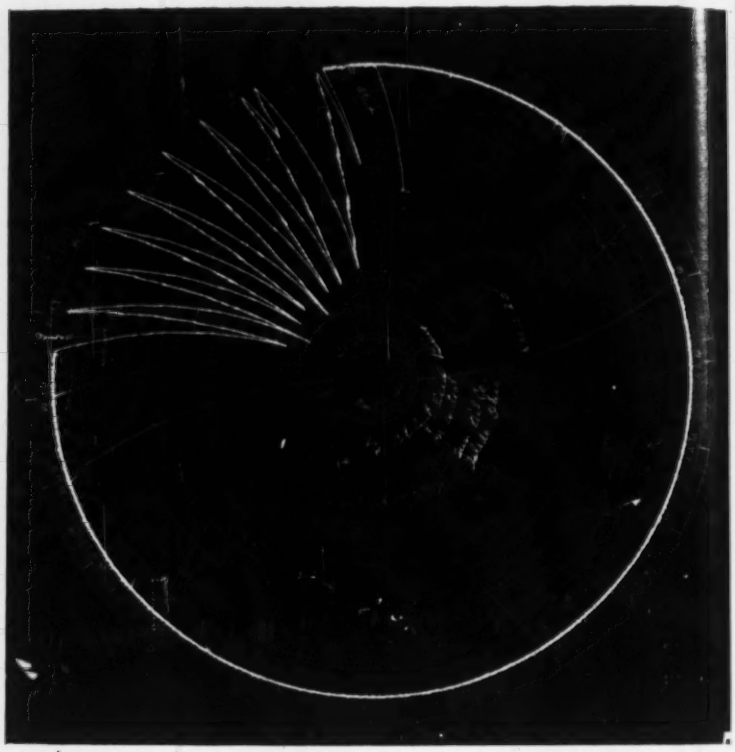


Fig. 4. Chart from Gagetron Level Control on Catalyst Feed Bin, showing response over a twenty foot range.

Section Secretaries and Meeting Data

AKRON
Fred Appel, 932 Columbia Ct., Barberton, Ohio. Tel: SH 3440
Fourth Tuesday, Meeting at 7:30 P. M., Akron Y.W.C.A.

ALBUQUERQUE
E. J. Burda, Sandia Corp., P. O. Box 5800, Albuquerque, N. Mex.
First Monday, Meeting at 8:00 P.M., Science Lecture Hall, Univ. of N. M.

ARUBA
K. H. Walker, P. O. Box 389, c/o Lago Oil & Tranpsort Co., Ltd., Aruba, N.W.I.
First Tuesday, Meeting at 7:15 P. M., Engr's Club.

ATLANTA
H. Kockritz, Fischer & Porter Co., 84 Peachtree St., Atlanta, Ga. Tel: CY 1269
Fourth Monday, Meeting at 7:45 P.M., Ga. Institute of Technology.

BALTIMORE
W. A. Dickinson, 2716 Dunbrook Ct., Baltimore 22, Md. Tel. Chesapeake 6879
Second Friday, Meeting at 8:00 P.M., Engr's. Club of Baltimore.

BATON ROUGE
John Q. Bass, 1517 Longwood Dr., Baton Rouge, La. Tel: 3-0283
Meeting monthly, no definite time, L.S.U. Physics Bldg.

BOSTON
Stephen E. Lord, 60 Braintree Ave., Quincy 69, Mass. Tel: MA 9-1066
Last Wednesday, Dinner at 6:30 P. M., Meeting at 7:00 P.M., 99 Club.

CALIFORNIA
D. C. Duncan, Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif. Tel: SY 4-8439
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P.M., Carolina Dines.

CENTRAL ILLINOIS
Thomas A. Carroll, 721 Hurlburt St., Peoria 6, Ill. Tel.: Peoria 4-8909
First Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M.

CENTRAL INDIANA
Richard F. Rieman, 3550 Euclid St., Indianapolis, Ind.
First Tuesday, Meeting at 7:30 P. M.

CENTRAL NEW YORK
Karl W. Robertson, Minneapolis-Honeywell Reg. Co., 121 W. Onondaga St., Syracuse, New York.

CHARLESTON
Clayton A. Williams, 303 E. 9th St., Belle, W. Va. Tel: 927871
First Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Kanawha Hotel.

CHICAGO
Floyd E. Ertaman, Rm. 1420 Fisher Bldg., 343 S. Dearborn St., Chicago, Ill. Tel: WE 9-0686
Third Tuesday, Dinner at 6:30 P. M., Meeting at 8:00 P.M.

CHINA LAKE
A. H. Staud, 1004 Michelson Lab., USNOTS, China Lake, Calif. Tel: 77882
Fourth Thursday, Meeting at 8:00 P.M., Michelson Lab, USNOTS.

CINCINNATI
L. W. Greene, 181 Market St., Aurora, Ind.
First Monday, Meeting at 8:00 P.M., Eng'r. Society Hqs.

CLEVELAND
A. E. Ehrke, 1732 East 291st St., Wickliffe, Ohio. Tel: WI 3-1036
Fourth Wednesday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Cleveland Eng'r. Society.

COLUMBUS
W. C. Myers, c/o Battelle Memorial Institute, 505 King Ave., Columbus, Ohio. Tel: UN 3191, Ex. 248
Third Thursday, Meeting at 8:00 P.M., Battelle Auditorium

CUMBERLAND
Clyde Babst, 225 Cecilia St., Cumberland, Md. Tel: 583-W
Tuesday after Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Algonquin Hotel.
Nov. 28: "The Saunders Type Valve," R. J. Kidde, Hills McCanna Co., Chicago, Ill.

DETROIT
Seymour Sterling, 13331 Linwood, Detroit, Mich. Tel: Tyler 5-1707
Second Wednesday, Meeting at 8:00 P.M., Rackham Bldg.

EASTERN NEW YORK
W. R. McKegg, c/o Gen. Engrg. & Consulting Lab., G. E. Co., Schenectady, N. Y.
First Tuesday, Dinner at 6:30 P.M., Meeting at 8:00 P.M.

GULF COAST
W. N. Sloan, E. I. Du Pont de Nemours & Co., Orange, Texas. Tel: 8411 Ext. 444
Third Tuesday, Meeting at 7:30 P.M., Lamar College.

HOUSTON
I. K. Farley, 2123 Travis St., Houston, Texas.
Last Monday, Meeting at 8:00 P.M., Engineers Club.

KANSAS CITY
L. E. Oberhelman, Standard Oil Co., Sugar Creek, Mo. Tel: MU 1227
First Tuesday, Meeting at 7:30 P.M., Univ. of Kansas City.

LOUISVILLE
H. C. Scherffius, 980 Palatka Rd., Louisville 8, Ky. Tel: Franklin 1265
Fourth Tuesday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
S. J. Mizuhara, 1075 Allard, Verdun, Quebec, Canada. Tel: TR 3252
Last Monday, Meeting at 8:00 P.M. Mechanics' Institute.

NEW JERSEY
Fred L. Crabbe, 4: East 42nd St., New York 17, N. Y. Tel: Vanderbilt 6-2906
First Tuesday, Dinner at 6:00 P. M. Meeting at 8:00 P.M., Essex House.

NEW ORLEANS
W. H. Haney, 2927 Music Avenue, New Orleans, La.
No Regular Date, Meeting at 8:00 P.M.

NEW YORK
F. B. Leslie, 8856 Commonwealth Blvd., Bellerose 6, N. Y. Tel: Fl 7-0645
Last Monday, Dinner at 6:00 P.M., Meeting at 7:45 P.M., Henry Hudson Hotel.

NIAGARA FRONTIER
Mrs. James L. Martin, 697 Potomac Ave., Buffalo 9, N. Y. Tel: GR 1450
Fourth Monday, Dinner at 6:00 P.M., Meeting at 8:00 P.M., Institute of Arts and Sciences, Buffalo.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9, Texas

NORTHERN CALIFORNIA
M. A. Dimmick, 5607 Alta Punta, El Cerrito, Calif. Tel: Be 5-1095

Third Monday, Meeting at 7:30 P.M., Angelo's, Emeryville.

NORTHERN INDIANA
J. Baum Beckman, 647 N. Waller Ave., Chicago 44, Ill. Tel: ES 8-7776
Third Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M., Gary Y.M.C.A.

OAK RIDGE
John H. Clark, 230 Canton Hall, Oak Ridge, Tenn. Tel: 5-9142
First Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M., Oak Terrace.

ONTARIO
John W. Huether, 311 Southerland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Meeting at 8:00 P.M.
Third Thursday, Meeting at 8:00 P.M. Friendship Hall, College St. United Church, Toronto

PANHANDLE
R. E. Harris, 228 Mays Bldg., Amarillo, Texas. Tel.: 31434.

PHILADELPHIA
C. W. Wood, 6908 Market St., Upper Darby, Pa. Tel: Clearbrook 9-3959
Third Wednesday, Meeting at 8:00 P.M., Bellvue Stratford Hotel.

PITTSBURGH
Miss Louise Suckfield, P.O. Box 2038, Pittsburgh 30, Pa. Tel: HI 1-1800
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel.
Pittsburgh Inspection & Gaging Committee, Second Tuesday, Meeting at 8:00 P.M., Wm. Penn Hotel. Tel: CE 1-5621

PRESQUE ISLE
Edwin P. Schuwerk, 445½ Halley St., L. P., Erie, Pa. Tel: 2-3349
Fourth Tuesday, Meeting at 8:00 P.M., G. E. Community Center, East Lake Rd.

RICHLAND
R. A. Nederhood, 2003 Trippe, Richland, Washington. Tel. 5-4442
Second Wednesday, Meeting at 7:30 P.M., American Legion Hall.

ROCHESTER
R. C. Schwarz, Jr., 1201 Granite Bldg., Rochester 4, N. Y. Tel: Monroe 4610R
Fourth Tuesday, Meeting at 8:00 P.M., Univ. of Rochester, Physics Lecture Hall.

SARNIA
J. J. Connors, 272 Elgin St., Sarnia, Ontario, Canada. Tel: 1970 W
Second Friday, Meeting at 8:00 P.M., Moose Hall.

SOUTH BEND
Sam M. Rouse, 436 Moccasin Ave., Buchanan, Mich. Tel: 678
First Thursday, Meeting at 8:00 P.M., Engineers Club, Hotel La Salle, South Bend.

SOUTH MICHIGAN
W. J. Sprau, 2509 S. Rose St., Kalamazoo, Mich.
Fourth Wednesday, Dinner at 6:30 P.M. Meeting at 8:00 P.M., Chicken Charlie's, Kalamazoo.

SOUTH TEXAS
H. C. Givens, La Gloria Corp., P.O. 637, Falfurrias, Texas. Tel: 122-W
First Thursday, Meeting at 7:30 P.M., Garner Aircraft Instrument School.

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516
First Wednesday, Meeting at 8:00 P.M., Engineer's Club of St. Louis.

TOLEDO
Morris L. Conner, 925½ Sherman St., Toledo, Ohio. Tel: MA 9403
Third Tuesday, Meeting at 8:00 P. M., Service Bldg., Toledo Edison Co.

TENNESSEE
N. M. Taylor, 16 Edgewood, Kingsport, Tenn. Tel: 3338J
No definite night, Dinner at 6:45 P.M., Meeting at 8:00 P.M., Hall's Dining Rm., Bristol Hwy.

TULSA
J. J. Fox, Phillips Petroleum Co., Phillips Bldg., Bartlesville, Okla.
First Monday, Meeting at 6:45 P.M., Engineering Bldg., Tulsa Univ.

TWIN CITIES
Alden Hine, c/o Pinkney & Hine, 552 Plymouth Bldg., Minneapolis 3, Minn. Tel.: Whittier 6420.
Fourth Tuesday, Dinner at 6:30 P.M. Coffman Memorial Union, U. of Minn.

WASHINGTON
Raymond E. Miller, 20-224 Naval Ord. Lab., White Oak, Md. Tel: JU 7-6742
Third Monday, Meeting at 8:00 P.M., P. E. P. Co. Auditorium.

WAYNE COUNTY
Robert Karr, 2455 Biddle Ave., Wyandotte, Michigan. Tel. 0167J
Third Monday, Snack after meeting, Larson's Cafe.

WILMINGTON
Dean Valentine, 34 N. Hill Drive, West Chester, Pa. Tel: 0293W
Third Tuesday, Meeting at 8:00 P.M. Harlan Public School, Wilm.

Regional Meeting

Philadelphia Section November 2, 1950
Bellevue-Stratford Hotel, Philadelphia, Pa.
"Industrial Waste Disposal—A Problem For Instrumentation"

Industrial waste treatment is definitely in the limelight today, and since there are many vital instrumentation problems to be solved, all instrument engineers are advised to take advantage of this first symposium. Plenty of time will be allowed in the program for worthwhile discussion of each paper.

—C. W. Wood, 6908 Market St., Upper Darby, Pa. Secretary, ISA Philadelphia Section.

Continued from page 1067

manufacturer of thermometers, pressure and temperature recorders, air operated controllers and dials, mercury-vapor and liquid filled systems. Must be good draftsman with shop production ideas and experience in technical instrumentation, able to supply sales dept. with answers to application problems. Location Detroit, Mich. Box 348.

INSTRUMENT ENGINEER graduate E. E. or M. E. with experience in design and maintenance instrumentation for chemical plant. Age 30-40. Location Oak Ridge, Tenn. Box 349.

INSTRUMENT ENGINEERS experienced in telemetering and instrument development design and application. Opportunity for advancement. Stimulating, challenging work. Location Buffalo, N. Y. Box 350.

INSTRUMENT ENGINEER graduate M. E. or Ch. E. experienced in all phases of instrumentation planning through panel board layouts, ordering specifications, installing instructions to tuning up and trouble shooting at start-up. Several years experience required. Location Bound Brook, N. J. Box 351.

AERONAUTICAL ENGINEER for evaluation of aerodynamic data, calculation of aerody. characteristics, review of flight test procedure and results. Degree in Aero Engrg. Several years in sub and supersonic design, wind tunnel testing, etc. Location New York, N. Y. Box 352.

APPLICATION ENGINEER (INSTRUMENTS) for application of electronic equipment to factory processes, schedule repair and calibration work in laboratory, design and construct equipment peculiar to electronic laboratory. Must be graduate E. E. Opportunity for advancement. Location Syracuse, N. Y. Box 353.

DIVISION ENGINEER (ELECTRICAL) graduate E. E. Must have good record on performance of directing work of others and getting job out on schedule. Design and field experience in power and lighting. Strong on design preferred. Electonics knowledge and experience desirable. Must have good administrative ability for directing groups of engineers and draftsmen. Experience in process industries desirable but in industrial or power acceptable. Location New York City. Box 354.

ASST. DIVISION ENGINEER Ph. D. in Chem. or Ch. E. capable of developing complete processes in chemical or industrial field, preparation of process and engineering flow sheets and material balance. Assist design engineers. Good working knowledge of chemical process equipment. Proven administrative ability to direct and plan activities or process engineering groups. Location New York, N. Y. Box 355.

ASST. DIVISION ENGINEER M. E. or Ch. E. with two years piping design experience in oil, process and power fields. Must have heavy administrative experience in running large design and drafting groups. Location New York, N. Y. Box 356.

ASST. DIVISION ENGINEER specialist in instrumentation. Must be college graduate with corresponding degrees. Age 30-40. Must have several years design experience in chemical processing industries. Location New York, N. Y. Box 357.

ASST. DIVISION ENGINEER Metallurgical graduate. Must be able to head-up a laboratory program and advise the engineering dept. on design. Essential: knowledge of heat treatments and selection of materials in process industries; knowledge and experience in fabrication of stainless steel, alloy specifications and materials for vessels and piping. Desirable: rounded factory, lab and steel mill experience; administrative ablity to plan and carry out engineering programs, experience in welding of carbon and stainless steels and other joining methods for nonferrous materials. Location New York City. Box 358.

ELECTRONICS ENGINEERS positions open in the development, design and testing of radar, microwave apparatus, telemetering, proportional control, servo-mechanism, system engineering. Excellent opportunities for advancement. Location Buffalo, New York. Box 359.

ELECTRONICS ENGINEERS B. S. degree or equivalent plus industrial experience. For work in laboratory under supervision of Western Electric Co. and Bell Telephone Lab. Ideal working conditions. Location New Mexico. Box 360.

ELECTRONICS PRODUCTION ENGINEER engineering graduate preferred but not essential; electronic training in CREI highly desired. Several years experience in mechanical design, selection of parts, etc. Considerable initiative. To review electronic design proposals, initiate such proposals, prepare production specs for electronic equipment, determine the most appropriate parts and materials for military application. Some travel. Location New York City. Box 361.

ELECTRICAL ENGINEERS one Senior and one Junior for design and development for electrical and electronic measurement and recording instruments. Includes overall supervision of a project from design and development to preparation for production. Should be engineering graduate with special emphasis on electronics, communications and instrumentation. Experience in commercial manufacturing organization desirable. Location Massachusetts. Box 362.

ELECTRICAL ENGINEER graduate E. E. with at least one year experience with electrical and electronic instrumentation as applied to flight test of aircraft. Position is a Civil Service G. S.—7 rating. $3825 year. No Civil Service exam required. Location Maryland. Box 363.

ELECTRICAL ENGINEER (SERVO-MECHANISMS) graduate E. E. with experience or graduate study in servo-mechanisms for research and development program on electrical control systems employing closed loop feedback circuits. Salary $3525-$5400 year depending on experience. Location Washington, D. C. Box 364.

MECHANICAL ENGINEERS for development and design of computers, control elements, servomechanisms. Mechanical design of electronic equipment for airborne use. Good understanding of vibration and shock problems is desirable. Excellent opportunity for advancement. Location Buffalo, N. Y. Box 365.

MECHANICAL ENGINEER graduate preferred. Knowledge of control equipment necessary. Involves machine design and application engineering in counters, recorders and industrial weighing equipment. Location Chicago, Ill. Box 366.

MECHANICAL ENGINEER graduate M. E. to perform development work on small mechanisms of composite design. Ten to twenty years experience. Underwater ordnance experience desirable. Knowledge hydrodynamics. Familiar with shop and drafting practices. Experience in military needs desirable. Occasional field trips. Location New York, N. Y. Box 367.

MATERIAL AND PROCESS ENGINEER graduate M. E. to evaluate manufacturing processes, methods and equipment. Prepare or review inspection procedure and material specs. for mech. equipment. Several years experience in inspection instruments, tool and fixture design, mfg. processes, govt. material specs. Location New York, N. Y. Box 368.

OFFICE ENGINEER for specifications and quotation preparation for meters and controls. Previous experience not necessary. Engineer graduate over 31 preferred. Location Chicago, Ill. Box 369.

PROJECT ENGINEERS Ch. E. or M. E. with ability to followup and get out engineering projects. Experience in project work in process industries essential. Familiar with welding and vessel codes. Can work with engineering flow sheets. Location New York, N. Y. Box 370.

PROPULSION ENGINEER graduate M. E. to evaluate design of propulsion equipment, calculate engine performance under all operating conditions, prepare test procedure and specs. Several years experience design and test of such units as liquid and solid fuel rockets, ram jets, gas turbines, etc. Familiar with engine mfg. methods. Location New York, N. Y. Box 371.

ENGINEERS (RESEARCH AND DEVELOPMENT) for missile instrumentation, electronics, radar, physical analysis, and precision mechanical design. Numerous openings for specialist in any one field or those having extensive general experience in one or more fields. Give complete resume of age, background, education, experience in first letter. Location California. Box 372.

RADAR ENGINEER to report, prepare engineering design studies. Some armed service operating experience with radar equipment and two years in industry in design, construction and operation of microwave equipment. Graduate. Must be able to work well with others. Location New York, N. Y. Box 373.

SERVO ENGINEER to prepare engineering design studies and production specifications, review design proposals, establish test criteria and procedure. Graduate engineer with some specialization in servo mechanisms. Several years experience in design and production of servo mechanisms. Must have initiative for independent work and be capable of working well with others. Location New York, N. Y. Box 374.

INSTRUMENT SALES ENGINEER graduate C. E. or M. E. experienced in process equipment. 30-40 years of age. For assistant to Dist. Mgr. in Pittsburgh area. Give complete details in first letter. Box 376.

INSTRUMENT SALES ENGINEER experienced in thermometers, air operated and self operated controllers, recorders and instrumentation application. Excellent opportunity for hard worker who can cover personally the home territory and assume direction of and increase present national agency representation program. Location Detroit, Mich. Box 377.

INSTRUMENT SALES ENGINEER for automatic controls and mechanical equipment in Chicago area. Over 31 years of age. Engineering graduate preferred. Box 378.

INSTRUMENT SALES ENGINEER for counting, weighing and control equipment. Experience in instrument field and knowledge of radiation equipment desirable. Extensive travel required. Headquarters Chicago, Ill. Box 379.

SALES REPRESENTATIVE to represent scientific instrument concern. Some sales engineering experience and field demonstrations at customer's plants required. Territory includes N. Y. State and N. Y. City, New Jersey, Maryland, Delaware, Virginia, W. Virginia, Pennsylvania and D. of C. Home Office Massachusetts. Box 380.

SALES AGENTS for expansion of sales in principal large cities for complete line of industrial thermometers, recorders, controllers, and dials. Old reliable company. Liberal commission which encourages good jobber and original equipment manufacturer's business. Main office Detroit, Mich. Box 381.

DEVELOPMENT SUPERVISOR to assume responsibilities for development, design and evaluation of airborne antenna for military aircraft. Full knowledge of measurement techniques and 8-10 years of related experience required. Location Texas. Box 382.

INSTRUMENT MECHANICS by large manufacturer of chlorine and caustic soda and chlorinated hydrocarbons, especially benzine. Must be experienced in process instrumentation. Forty hour week. $1.77 hr. Location West Virginia. Box 383.

INSTRUMENT MECHANIC high school graduate under 35 with experience in meter work and allied field. For chart changing, meter repair, control repair, combustion testing. Excellent opportunity to work up to Test Engineer. Large steel mill in Cleveland, Ohio. Box 384.

INSTRUMENT MECHANICS installation of special flight test recording equipment in experimental aircraft, also maintenance of such equipment and calibration work. Location California. Box 385.

TECHNICIANS (ELECTRONIC) for construction of special or custom built electronic measurement and recording instrument and to act as lab assistant to engineers. Must be familiar with laboratory instruments and measurements; able to work from schematic and blueprints; capable of shooting trouble; experience in actual construction; assembly and wiring of laboratory apparatus. Location Massachusetts. Box 386.

INSTRUMENT TECHNICIANS experienced in strain gauges, recording oscillographs and flight test equipment. Location Buffalo, N. Y. Box 387.

INSTRUMENT REPAIRMEN four first class instrument repairmen with general process instrument experience in either chemical plant or petroleum refinery. Location Texas. Box 388.

The following openings are with the U. S. Naval Ordnance Laboratory. For application forms write direct to the following and not to the Society office. U. S. Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland.

PHYSICIST, $6400 per annum. The incumbent will direct basic research work in physics performed with the help of a small group of professional and sub-professional personnel. He will investigate various unusual effects encountered when 700 ft/sec missiles strike water. This is done in the laboratory. A Ph.D. degree is desirable but not absolutely necessary. The training should be broad and not necessarily in hydrodynamics. Definite evidence of research ability is required.

PHYSICIST $6400 per annum. A man with acoustical experience would be most desirable. Work is in the field of underwater acoustics. A person familiar with concepts such as acoustical impedance, means of dealing with acoustic problems, and who is interested in this work would be most useful. In the absence of specialized experience, a man with a broad general physical background would also be considered.

PHYSICST $5400 per annum. A comprehensive knowledge of classified physical principles, especially with regard to theoretical and applied mechanics, hydraulics, electromechanical analogues, electrical circuit theory, electronics and acoustics. Experience in production processes, design drafting, pressure and electrical measurements is mandatory. A Bachelor of Science degree with graduate work in physics is a basic requirement. A thorough knowledge of electricity and magnetism, electronics and solid-state physics. A practical and theoretical knowledge of electronics, amplifiers, and electrical measuring instruments. At least 3 years experience in electronic and magnetic circuits, magnetic field measuring instruments, and underwater ordnance.

PHYSICIST $3825 per annum. A Bachelors degree in Physics. One year experience in applied physics. A knowledge of scientific literature. Practical and theoretical knowledge of electromagnetic field behavior. Ability to use a variety of physical and electrical measuring instruments and a basic knowledge of their capabilities and limitations. A knowledge of theoretical and applied mechanics, electricity and magnetism, electronics, and mathematics.

MECHANICAL ENGINEER $4600 per annum. Ammunition Division—Electro-Mechanical Sub-Division—Electro-Mechanical Fuze Section. Involves development work on electro-mechanical fuzes for all types of weapons. Mechanical design of small mechanisms to meet unusual operating conditions; laboratory and field testing of fuzes in simulated or actual weapons; coordination with outside contractors; engineering for quantity production; preparation of specifications; and paper work involving report writing, test and program planning and drafting. Opportunity exists for branching out into electrical engineering fields in work on fuzes having electrical components and circuitry.

MECHANICAL ENGINEER $4600 per annum. A position with opportunity for a mechanical engineer possessing design experience and a good deal of ingenuity in dealing with small mechanisms. Work in this field is similar to design of compact and complex mechanical instruments. Some knowledge of electronics would be of assistance in view of the trend to employ electronic components in this type of equipment.

MECHANICAL ENGINEER $4600 per annum. Ammunition Division—Mechanical Sub-Division—Bomb and Special Fuzes Section. Involves development work on mechanical fuzes for all types of weapons. Mechanical design of small mechanisms to meet unusual operating conditions; laboratory and field testing of fuzes in simulated or actual weapons; coordination with outside contractors; engineering for quantity production; preparation of specifications; and paper work involving report writing, test and program planning, and drafting.

ELECTRONICS ENGINEER $6400 per annum. A man with experience in pulse techniques or in the treatment of video-like signals would be of particular interest. A small highly specialized group is engaged in the developing of systems which are similar in behavior to radar systems viewed beyond the IF amplifier. Excellent equipment is available and the work is unusually interesting.

ELECTRONICS ENGINEER $5400 per annum. Thorough knowledge of electric circuit theory, electro-mechanical and electro-acoustical analogs, acoustics, theoretical and applied mechanics, production process and methods, design drafting, piezoelectric and pyroelectric crystal behavior, as well as considerable experience in the field of electrical and acoustical measurements. Practical and theoretical knowledge of electronics and amplifiers, electromagnetic field behavior and a thorough knowledge of various types of measuring instruments, their limitations and posibilities. At least three years experience in electric, and magnetic circuits, magnetic field measurements and firing mechanisms for underwater ordnance.

ELECTRONICS ENGINEER $4600 per annum. A Bachelor of Science degree in Electrical Engineering. A thorough knowledge of electronics. A good knowledge of physics and applied mathematics. At least three years of experience in the design of electronic equipment such as amplifiers, oscillators, power supplies, circuits employing thyratrons, light sensitive cells, etc.

ELECTRICAL ENGINEER $4600 per annum. Ammunition Division—Electro-Mechanical Sub-Division—Electro-Mechanical Fuze Section. Involves development work on electro-mechanical fuzes for all types of weapons, electrical design of circuits and development of special components for small electro-mechanical devices to meet unusual operating conditions; laboratory and field testing of fuzes in simulated or actual weapons; laboratory work in development circuits and performing electrical tests; coordination with outside contractors; engineering for quantity production; preparation of specifications; and paper work involving report writing, test and program planning and drafting. Opportunity exists for branching out into mechanical engineering fields in work on fuzes involving unique mechanical design problems in development of small mechanisms.

ELECTRONICS ENGINEER $3825 per annum. A small highly specialized group is engaged in the developing of systems which are similar in behavior to radar systems viewed beyond the IF amplifier. Excellent equipment is available and the work is unusually interesting.

ELECTRONICS ENGINEER $3825 per annum. A thorough knowledge of electrical engineering and basic electronic principles. One to two years progressive experience in design of special electronic mechanisms. A knowledge of underwater acoustical phenomena and acoustical measurement technique is desirable. A thorough knowledge of electronic engineering is required which necessitates a degree in electrical or electronic engineering with from one to two years progressive experience in design of special electronic mechanisms. A knowledge of underwater naval ordnance and electromagnetic theory is desirable.

ELECTRICAL ENGINEER FOR MAGNETIC MATERIALS $3825 per annum. Perform engineering duties in connection with the development of magnetic amplifiers for servo systems and other ordnance applications. Construct and carry out test development work on experimental units, selecting and using oscellographs, meters, and test equipment necessary for the proper pursuance of the program. Work with supervisor on basic system design and, working out only important changes with him from that point on, carry the entire project step by step through the development stage. Man should have B.S. degree in Electrical Engineering (degree in Physics or Electronic Engineering also possibly acceptable). Familiar with normal laboratory test equipment and be able to use soldering iron and make experimental breadboard test assemblies. Experience in transformer work or with servomechanisms would be desirable but not mandatory. Practical engineering approach to problems preferred to theoretical mathematical analysis system.

JOURNAL of the
Southern California Meter Association

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Calculation *of* Orifice Meter Charts *by the* Square-root Planimeter Method

By J. T. CORTELYOU, Southern California Gas Company

THIS PAPER is intended to present a mechanical device that will shorten and simplify the process of reading square-root charts. It could be applied to direct-reading (M) charts if the pressure pen were set to record absolute pressure, but is commonly used to read square-root charts only. This device is known as the Square Root Planimeter.

The principle on which the Square Root Planimeter operates is based on the assumption that the average value of the square root of the differential, h, for a twenty-four hour period, times the average value of the square root of the absolute pressure, P_a, for a twenty-four hour period, is equal to the average value of the instantaneous square roots of the products of the differential times the absolute pressure during the twenty-four hours; or, in the case of the square-root chart, where we are always dealing with the square roots of values, the average differential reading from the chart times the average pressure reading from the chart equals the average of the instantaneous products of the differential readings times the pressure reading.

If this assumption were correct, any device that could quickly and easily give the average value of the recorded records on the chart would greatly speed up chart reading. This assumption is true within limitations, as will be discussed later.

The Square Root Planimeter is a device whereby the chart is put over a movable hub which is held loosely in a curved slot on a base plate. A pointer is set on a given point on the record to be read and the counter is set to zero. The chart is turned through 360 degrees of revolution, keeping the record to be read under the pointer at all times. This is accomplished by moving the hub in the slot in the base plate as required while rotating the chart. When 360 degrees of revolution have been made, the counter will read the average value of the record traced. The instrument is so constructed that the average will be the numerical average of chart values (hs or Ps_a) rather than an average of the differential or the absolute pressure (h or P_a).

The proper use of a Square Root Planimeter has been shown and the amount of labor that this instrument can save may be seen. However, there are definite limitations on its use which must not be overlooked.

We said that the principle of the planimeter was based on the assumption that the product of the average differential reading times the average pressure reading equalled the average of the products of the instantaneous readings. And we said that within limitations this was true.

The limitation is this: the above assumption is strictly true only when one of the records is absolutely constant. It is practically true if one of the records is nearly constant. It has been determined that for many orifice meter charts, the pressure record is sufficiently constant to make the assumption true within the limit of error of normal chart reading. However, a great many charts have a pressure record which varies greatly, and these charts should *not* be read on a Square Root Planimeter.

This fact can be demonstrated by three numerical examples which follow:

Case I—Pressure varies greatly

hs	ps_a	hs × ps_a
8	6	48
9	4	36
5	5	25
3	7	21
6	8	48
31/5 = 6.2	30/5 = 6.0	178/5 = 35.6

$$\text{Error} = \frac{37.2 - 35.6}{35.6} = 4.5 \text{ percent}$$

Case II—Pressure varies slightly

hs	ps_a	hs × ps_a
8	7	56
6	6	36
5	7	35
4	6	24
7	7	49
30/5 = 6.0	33/5 = 6.6	200/5 = 40.0

$$\text{Error} = \frac{40.0 - 39.6}{40.0} = 1 \text{ percent}$$

Case III—Pressure does not vary

hs	ps_a	hs × ps_a
7	7	49
8	7	56
5	7	35
4	7	28
6	7	42
30/5 = 6.0	35/5 = 7.0	210/5 = 42.0

$$\text{Error} = \frac{42.0 - 42.0}{42.0} = 0 \text{ percent}$$

From advanced mathematics and the study of many more such examples, it can be shown that the error as shown is not only a function of the variation in pressure, but is a function of the manner in which the differential varies while the pressure is varying. However, because this effect is so complex and because the differential on most charts varies in much the same way, the error of reading by Square Root Planimeter will be considered a function of pressure variation only.

Further, when using a Square Root Planimeter, the error in chart reading resulting from variation in pressure may be either positive or negative. Therefore, a Square Root Planimeter may be used to read the chart from a given meter where the pressure varies considerably, and over a long period of time the cumulative reading error will, in all probability, be very small because of the law of probability and the compensating nature of individual errors.

November Meeting: Thursday the 16th, Rio Hondo County Club, Downey, Calif. Dinner at 6:30, meeting at 8:00 p.m.

Features: (1) Steam Traps—Personal experience with Admiral Byrd in 1941 and personal experiences of the South African Tour, by L. C. Musselman; (2) SCMA Meter Course.

Read by F. M. Partridge at regular meeting of the Southern California Meter Association, July 20, 1950.

Chart Reading *by the* Emco McGaughy Integrator Method

By W. J. KENNEDY, Southern California Gas Company

IN THE PAPERS presented tonight by Mr. Partridge on the sight-reading and planimeter methods of reading charts, it was pointed out that certain factors must be considered when using these chart-reading methods to assure accurate results.

By the McGaughy integrator method it is possible to read the differential pressure and the static pressure to the same degree of accuracy as these instantaneous values are recorded on the chart, regardless how widely these records may vary.

Before proceeding with the chart reading process, it may be well to explain the working principle of the integrator. The integrator operates through translating into revolutions and multiplying the three given values of the chart: time, square root of the pressure, and square root of the differential pressure, and summing up the products in terms of revolutions. An infinite number of instantaneous values are multiplied and summed for each chart.

The machine consists of three disks or plates, which are termed the chart plate, the time plate, and the pressure plate. The time plate and the chart plate are geared together in constant ratio and are driven by a variable-speed motor. The pressure plate is located above the time plate, and, geared to the pressure plate, is a small steel disk roller termed the pressure roller. This roller bears on the face of the time plate and is shiftable across it from center to the outside edge. By shifting the position of the pressure roller, it is possible to change the speed ratio between the time plate and the pressure plate.

A second roller, termed the differential roller, is shiftable across the face of the pressure plate and directly connected to this roller is a revolution counter. Two pen arms equipped with fountain pens rest on the chart plate. These pen arms contact the face of the chart when it is resting on the chart plate. The ends of these arms are connected through a system of levers and square-root cams, which are attached to the static pressure and the differential carriage rollers, respectively. The linkage is so arranged that the pen arms serve to move the carriages so that at any time the point of contact of these rollers with the respective plate surfaces will correspond in revolutions respectively to; the square root of the absolute static pressure being registered at that instant by the pressure pen and

The square root of the differential pressure being registered at that moment by the differential pen.

The control arm handles on the front of the machine serve as a means to move the pressure and the differential arms across the face of the chart while tracing the two recorded curves. The integrator is operated by means of the two arm handles and a foot control. The control arm handle operated with the right hand controls the differential pen, while the arm handle operated with the left hand controls the static pen. The static tracing pen is filled with red ink and the differential tracing pen is filled with blue ink. The operator then traces the pen with the blue ink over the differential pressure line and the pen with the red ink over the static pressure line.

Before the chart is placed on the machine for tracing, all the points on the chart where readings are to be taken should be marked. Readings in addition to the start and end of the chart may be required for the following reasons:

1. Change of orifice coefficients due to change of plate or static spring.
2. Use of 48-hour charts where daily volumes are necessary.
3. Division of the chart because of contract change.
4. Reading of overlaps and underlaps for purpose of correcting the volume measured to standard day basis.

After the chart has been marked for integration, it should be placed on the machine. The counter reading at the start should be recorded in the space provided on the chart. The differential pen should be placed on the exact arc line of the starting position on the chart. The static pen is also placed on the chart. The chart weight should be placed on the post in the center of the chart plate, the time indicator released, and the chart weight pushed into place, which forces the needles on the chart plate through the surface of the chart to prevent chart slippage. The control arms are then moved so that the static and differential pens rest on the exact starting point on the the chart. When the chart is being integrated and the differential goes to zero for a short interval of time during the revolution of the chart, it is necessary only to move the differential pen to the zero line. When this is done the counter will not register.

The pens which pivot on the pen arms are then tilted back, tilting first the differential pen then the static pen. The chart is then removed and the final counter reading taken and recorded in the space provided for the stop reading.

One of the many advantages of the integrator method of reading charts is the accurate reading of charts that have erroneous recordings due to loss of mercury or movement of the static pen or differential pen by rough chart changing. When the gage is off zero and the differential pressure varies throughout the range of the chart, it is wrong to apply a percentage correction factor to the chart reading because the gage capacity varies non-uniformly from zero to maximum of the chart. The method for correcting such an error is by the use of a set of dividers which are fitted to a pen cap placed on the differential pen of the integrator with the divider point adjusted so that it does not touch the chart. Then the distance between the tip of the divider and the tip of the integrator pen can be adjusted to correspond to the amount that the gage was in error. The line that is recorded by the gage can be traced with the tip of the tracing pen divider and the integrator will then integrate and record a line where the gage should have recorded. In this way, an accurate corrected reading is obtained regardless of how much the differential pressure may fluctuate. Correction of error in the static pressure recording may be made in the same manner.

The integrator should be checked at least twice daily, preferably at the beginning and the middle of each day. This will provide a record which will prove the accuracy of charts calculated between tests. This may be accomplished by setting the static and differential pens on several combinations of static and differential lines on the chart and tracing the constant values for the complete revolution of the chart. Our machines are kept within zero and plus or minus 0.3 percent.

Certain flow conditions require both a 10-inch and a 50-inch differential gage. Usually the static pressure is recorded on the 50-in. chart only. To provide a static record on the 10-in. chart, the 50-in. and the 10-in. charts are matched as to exact time and, with a sheet of pencil carbon paper placed between them, the pressure record from the 50-in. chart may be traced on the 10-in. chart for the period that the 10-in. chart is to be read. The integrator is constructed so that Emco, Foxboro, and Westcott charts may be integrated.

A change of pen-arm assembly is required for the reading of each type of chart. It is, however, desirable to standarize on one type of gage.

The use of "M" charts (pounds pressure gage and differential pressure in inches of water) require that the static pen be readjusted for each range of "M" chart used. For consistent results

Presented at regular meeting of the Southern California Meter Association, July 20, 1950.

in chart calculation, it is desirable that square-root charts be used. The use of these charts requires but one setting of the static pen and thereby reduces the probability of error due to pen-arm adjustment.

The charts of our system to be read are from transmission, Company-check, and Industrial Sales meters, and it is required that all be read to a high degree of accuracy. A fully trained operator can read these charts in approximately 3.2 minutes per chart. New operators show considerable improvement during the first six months. The average time for a new operator to read a 48-hour chart during the first month of training is approximately 13 minutes per chart and, at the end of the sixth month the time is reduced to 4.5 minutes per chart. Maximum efficiency is reached by the operator between the sixth and twelfth month, depending upon the aptitude of the operator.

Chart reading by the integrator method was particularly advantageous during the war years when manpower was short and the work-load heavy. It is advantageous at the present time because of the greater production to be had with considerably less personnel.

The machine that we will use to demonstrate this method of chart reading at the end of the meeting has been in use since 1938. I believe it was the first integrator of this type to be used west of the Rocky Mountains. During the past twelve years it has integrated approximately one million charts.

The orifice meter equation for chart reading was explained in the first paper, but when reading square root charts on the Emco-McGaughy integrator, the equation becomes:

$$Q = C_v' \times X \times I$$

Q = Quantity

where C_v' = Hourly Coefficient (square root charts)

X = Difference between the start and stop reading of the integrator. For a 24-hour chart this is the equivalent of the sum of 24 one-hour extensions of the static and differential pressures.

I = Integrator Machine Factor

The formula for the integrator factor "I" is:

$$I = \sqrt{\left(\frac{\text{chart range}}{500 \text{ lb.} / 100 \text{ in.}}\right)}$$

where I = Correction factor for the use of the Emco-McGaughy integrator.

Note: The machine is designed with a constant of 1.000 at the chart range at 500 lb./100 in.

Following is an example of the calculation of the integrator factor when using square root charts. Since the correction for the square root charts is 1.000 for the chart range of 100 lb.=100 in., the equation becomes:

$$\sqrt{\left(\frac{100 \text{ lb.}/100 \text{ in.}}{500 \text{ lb.}/100 \text{ in.}}\right)} = 0.4472$$

In order to simplify the calculation, the integrator machine factor "I" is included in the orifice coefficient. It is combined with the "M" factor which is applied to the coefficient when square root charts are used. This reduces the equation to:

$$Q = C_v'' \times X$$

where C_v'' = Hourly coefficient for square root charts read on integrator

X = Difference between the start and stop readings

EXAMPLE

$$Q = C_v'' \times X$$

where $C_v'' = 1500$

$X = 450$

7600 stop read

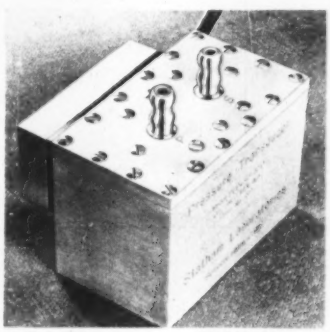
7150 start read

450 Diff.

$Q = 1500 \times 450$

$Q = 675{,}000$ cu. ft.

STATHAM DYNAMICALLY BALANCED PRESSURE TRANSDUCER MODEL P69



We are proud to announce the new Model P69 pressure transducer whose dynamically balanced construction assures long life and excellent performance under conditions of vibration and acceleration such as are encountered in flight test and guided missile applications. The acceleration response of the Model P69 pressure transducer is less than 0.1% of full scale per G up to 10G in any axis.

The Model P69 pressure transducer is temperature compensated over the range −65° F. to +250° F. Zero shift with temperature is not more than 0.01% of full scale per degree Fahrenheit, while the change in sensitivity is not more than 0.01% per degree Fahrenheit when operated with a constant voltage input circuit.

Please request Bulletin No. 3.3

We invite correspondence with our engineering staff when you are considering instrumentation for the measurement of acceleration, pressure, force or displacement.

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"STRAIGHT-LINE"
TEMPERATURE CONTROL
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XACTLINE

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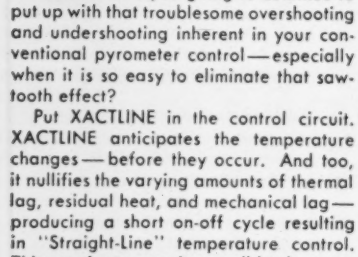
Overshooting
Undershooting

Are you going to continue to put up with that troublesome overshooting and undershooting inherent in your conventional pyrometer control—especially when it is so easy to eliminate that saw-tooth effect?

Put XACTLINE in the control circuit. XACTLINE anticipates the temperature changes—before they occur. And too, it nullifies the varying amounts of thermal lag, residual heat, and mechanical lag—producing a short on-off cycle resulting in "Straight-Line" temperature control. This performance is possible because there is no dependence upon mechanical parts—XACTLINE operates electrically.



Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.

XACTLINE is applicable to any indicating or recording pyrometer control of the millivoltmeter or potentiometer type. It should be used wherever close temperature control is required—any type of electrically heated oven, furnace, kiln, injection molding machine, and fuel-fired furnaces equipped with motor-operated or solenoid valves.

XACTLINE is a complete unit. No adjustment or coordination with the control instrument is required regardless of the size of the furnace, length of the heating cycle, or size of the load. Installation is very simple—can be either flush or surface mounted.

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1087.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

S-628 AUTOMATIC VALVE SPECIALTIES. 76-page Condensed Catalog A-50 illustrates, describes, and gives price list on maker's valve specialties (pressure regulators, altitude valve, pump governors and strainers; lever, float and motor operated valves, pilot valves; back pressure, relief and non-return valves, steam trap and air vent; liquid level controllers; solenoid valves; "Dia-ball" transmission unit and applications); also contains capacity charts.—Davis Regulator Co., 2541 S. Washtenaw Ave., Chicago, Ill.

S-629 RELATIVE HUMIDITY CALCULATOR-INDICATOR. 2-page Bulletin 1294 illustrates and describes maker's "Tag Humidicator" pocket-size humidity indicator with attached slide calculator; covers principle, features, and specifications.—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

S-630 SHOCK, VIBRATION MOUNTS. 12-page Catalog 504 illustrates and describes maker's shock and vibration mounts for industrial, marine and mobile equipment (from heavy machinery to sensitive instruments); covers mounting methods, characteristics, applications, construction; includes section on application principles, and deflection and isolation-efficiency curves.—Barry Corp., 173 Sidney St., Cambridge 39, Mass.

S-631 MICHROPHOTOMETER. 4-page Bulletin 2182 describes and illustrates maker's light-scattering indicating and recording microphotometer which measures to 20 micromicrolumens of scattered light; covers features, specifications, typical uses, accessories and replacements.—American Instrument Co., Inc., 8030-8050 Georgia Ave., Silver Spring, Md.

S-632 MECHANICAL DIFFERENTIALS.—4-page bulletin illustrates and describes maker's mechanical differentials; covers types and sizes, specifications for ordering, construction notes.—Arma Corp., 254 36th St., Brooklyn 32, N. Y.

S-633 D-C. AMPLIFIER. 8-page bulletin describes and illustrates maker's laboratory type d-c. amplifier; covers operation, applications, advantages, models available, general specifications, prices.—Manning, Maxwell & Moore, Inc., Stratford, Conn.

S-634 "TAG TALKS." 2-page July 1950 issue of this house organ features article on maker's "Minicorder" small recording thermometer for refrigerated vehicles, cabinets and compartments; covers features, models, ranges.—TAGliabue Instruments Div., Box 414, Weston Electrical Instr. Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

S-635 "WHAT'S NEW FOR THE LABORATORY." 16-page, No. 11 issue of this catalog describes and illustrates various laboratory apparatus, instruments, chemicals and glassware as supplied by Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

S-636 ORIFICE EDGE GAGE. 2-page bulletin illustrates and describes maker's orifice edge gage (designed by Dr. Howard Bean of NBS) for inspection of sharp edges of metering orifices; covers features, use, and ordering information.—Lovins Engineering Co., 8203 Cedar St., Silver Spring, Md.

S-637 PORTABLE MICROFILM READER. 2-page bulletin describes and illustrates maker's "PDA" portable microfilm reader; covers features, use, price.—Lovins Engineering Co., 8203 Cedar St., Silver Spring, Md.

S-638 PROVING RINGS. 2-page bulletin describes and illustrates maker's direct-reading proving rings for calibrating testing machine loads; covers sizes, capacities, weights, and dimensions.—Steel City Testing Machines, Inc., 8843 Livernois Ave., Detroit 4, Mich.

S-639 SPECTRUM ANALYZER. 2-page bulletin illustrates and describes (Vectron, Inc.) spectrum analyzer; covers features, uses, specifications.—Robert A. Waters, Inc., 4 Gordon St., Waltham 54, Mass.

S-640 RAMMER-COMPRESSION TESTER. 2-page bulletin describes and illustrates maker's combination rammer-compression tester; covers features, construction, operation, advantages, accessories.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

S-641 MAGNETIC MOUNTING DEVICE. 2-page Bulletin 600 illustrates and describes maker's "Miti-Mite" magnetic holder for test indicators and maker's "Handi-lites"; covers features, specifications, applications, prices.—Enco Mfg. Co., 4522-24 W. Fullerton Ave., Chicago 39, Ill.

S-642 TAP-CHANGING TRANSFORMERS. 2-page Bulletin HD-750 describes and illustrates maker's 36-step and 72-step tap-changing transformers; covers uses, construction, operation and accessories, specifications.—HeviDuty Electric Co., Milwaukee 1, Wis.

S-643 TRANSVERSE TEST CORE MAKER. 2-page bulletin illustrates and describes maker's transverse test core maker; covers features, construction, operation, advantages.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

S-644 TRANSVERSE CORE TESTER. 2-page bulletin describes and illustrates maker's transverse core tester; covers construction, operation, advantages, accessories.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

S-645 SCALERS. 2-page bulletin describes maker's computing scalers (basic units); covers features, uses in schools and labs, dimensions, types and capacities.—Condor Radio, 6501 W. 83rd St., Los Angeles 45, Calif.

S-646 FLOW REGULATORS. 2-page bulletin describes and illustrates maker's adjustable flow regulators for cylinder speed control over a 50 percent range, to 3000 psi.; covers uses, engineering data, ordering instructions.—Waterman Engineering Co., 721 Custer Ave., Evanston, Ill.

Instrument Engineer, experienced in watch manufacture, design and electronics. Good position with excellent future. Good living and working conditions in Midwestern Suburb. State age, experience and salary desired in application. Box 185, Instruments Publishing Company, 921 Ridge Avenue, Pittsburgh 12, Penna.

S-647 MAGNETIZED MACHINISTS' LEVEL. 4-page brochure illustrates and describes maker's magnetized level for machinists, steam fitters, plumbers, welders and other metal workers; covers features and uses.—The Buckeye Plastic Corp., 1220 Huron Rd., Cleveland 15, Ohio.

S-648 METAL CLAD SWITCHGEAR. 8-page Bulletin 18B6142A describes and illustrates maker's metal-clad switchgear for all-weather protection in outdoor operation; covers features, advantages; contains table of ratings and dimensions, floor plan, diagrams of standard assemblies, circuit arrangements for standard circuit breaker units.—Allis-Chalmers Mfg. Co., 942 S. 70th St., Milwaukee, Wis.

S-649 MACH NUMBER CHART. 16 by 11-inch chart gives standard values for Mach number measurement of high speeds, indicated air speed, differential pressure, altitude and absolute pressure; has table of pressure ratios, differential pressures, stagnation pressures for Mach numbers.—Kollsman Instrument Div., Square D Co., 80-08 45th Ave., Elmhurst, N. Y.

S-650 "CEC RECORDINGS." 12-page Vol. 4, No. 3 issue of this house organ features articles on maker's "Type 5-116" recording oscillograph, "Model 21-103" mass spectrometer, "Type 1-118" carrier amplifier, "Model 26-103" portable "Titrilog," and articles titled "Some Mass Spectrometer Applications in the Electronics Industry" and "Recording Galvanometers and How to Use Them."—Consolidated Engineering Corp., 620 N. Lake Ave., Pasadena 4, Calif.

S-651 MINIATURE SPEED CHANGERS. 4-page Bulletin 100 (revised) illustrates and describes maker's "Classes A, B, and C" miniature fixed-ratio speed changers; covers features, advantages, ordering infomation and Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.

S-652 FLOW REGULATOR. 4-page Bulletin 502 describes and illustrates maker's direct acting flow regulator; covers features, advantages, capacities; contains performance chart and cutaway illustration.—W. A. Kates Co., 430 Waukegan Rd., Deerfield, Ill.

S-653 "LANCO APPARATUS NEWS." 8-page Vol. 2, No. 3 issue of this house organ features articles on "Beckman" automatic titrator, stainless steel laboratory trays, graduates, etc., and other laboratory equipment.—Arthur S. LaPine & Co., 121 W. Hubbard St., Chicago 10, Ill.

S-654 CAPACITORS. 12-page Catalog AC-2 pictures and describes maker's electrolytics, molded paper tubulars, oil paper capacitors, "Metalite" self-healing subminiature metallized paper capacitor; covers specifications and price; also lists standard r-f filters for aircraft and heavy-duty applications.—Astron Corp., 255 Grant Ave., East Newark, N. J.

S-655 COLORIMETER FOR COTTON. 2-page bulletin describes and illustrates maker's automatic colorimeter for cotton; shows interior view of instrument.—Henry A. Gardner Lab, Inc., 4723 Elm St., Bethesda 14, Md.

S-656 PRESSURE, TEMPERATURE REGULATORS. 32-page Condensed Catalog 350 illustrates and describes maker's pilot-operated pressure and temperature regulators; covers features, advantages, capacity and flow data, operating cycle; also covers strainers, thermostats, desuper-heaters, electrically-controlled regulators and flange standards, dimensions and weights.—Spence Engineering Co., Inc., Walden, N. Y.

S-657 HAND TACHOMETERS. 4-page bulletin describes and illustrates maker's hand tachometers; covers features, advantages, specifications.—O. Zernickow Co., 15 Park Row, New York 7, N. Y.

S-658 HAND TACHOGRAPH. 2-page bulletin illustrates and describes maker's portable hand tachograph for speed control and test recording; covers features, specifications, dimensions and weights; shows sample charts.—O. Zernickow Co., 15 Park Row, New York 7, N. Y.

S-659 "hp JOURNAL." 4-page Vol. 1, No. 12 issue of this house organ features articles titled "A New Monitor for FM Communications Services" on maker's "Model 337" FM monitor, and "New Aural and Video Monitors for TV Stations"; includes specifications.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

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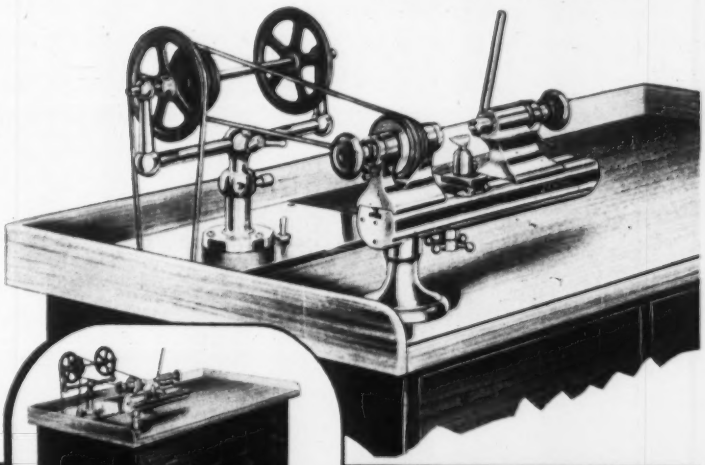

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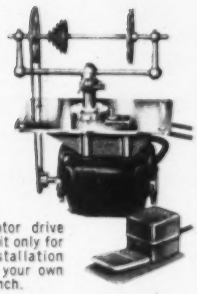

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